THE ENGINEER

JUNE 11, 1954

### Capital Requirements for Financing B.E.A. Power Projects

AMONG the projects which the British Electricity Authority hopes to be able to plan within the next few years is a large atomic power station with standard 60MW generating units. Reference to this scheme and others is made in a booklet "Power and Prosperity," published last week by the Authority, price 1s. This booklet indicates the progress made in recent years, reveals future plans to meet the growing demand for power, and concludes with a financial survey indicating the necessity for increasing the electricity supply industry's borrowing powers. The detailed design of the nuclear power station will depend upon results obtained with the experimental power station now being built at Calder Hall in Cumberland. The building of a large new power station which will house 200MW turbo-generator sets is also projected by the Authority. This project is part of a programme to install nearly 10,000MW of new generating plant which will be required in the next six years. Annual consumption is likely to be increased from 52,000 million units in 1952–53 to 80,000 million units in six years' time. As revealed in the White Paper published last week, the B.E.A. programme of development to 1960 approved by the Minister of Fuel and Power, involves capital expenditure of over £1400 million. This covers the installation of some 10,000MW of additional generating capacity, the construction of the 275kV Supergrid and other transmission works, and the extension of the distribution networks including rural electrification. The Authority and the Area Boards estimate that they will be able to finance over £400 million of this total from internal resources (principally depreciation provisions), leaving approximately £1000 million to be raised by external borrowing. This would bring the aggregate borrowings reckonable against the limit prescribed by Parliament to almost £1500 million. With the suggested severance of the two Scottish Area Boards and the corresponding generation divisions, however, part of this amount will be the responsibility of the proposed South of Scotland Electricity Board, and in consequence the Gas and Electricity (Borrowing Powers) Bill, which has been given its first reading by Parliament, provides for the extension of the Authority's borrowing powers from £700 million to £1400 million.

### Opening of Woodhead Tunnel

THE double-line railway tunnel of British Railways at Woodhead was officially opened on June 3rd, the opening ceremony being performed by Mr. A. Lennox-Boyd, Minister of Transport and Civil Aviation. The tunnel has been referred to on a number of occasions in these columns, particularly on March 19th last. It forms part of the Manchester–Sheffield–Wath electrification scheme, and has been under construction since 1949. The ceremony was of particular note because the tunnel, which has a length of 3 miles 66 yards, is the only major railway tunnel which has been built in this country for many years. Construction was attended by many difficulties, and large falls of rock were experienced; but these difficulties were solved by original methods of construction, which included a system of by-pass tunnels, driven parallel to the pilot tunnel, and connecting with it at various points, so that the enlargement of the pilot tunnel could be carried on at a number of places simultaneously. The Woodhead tunnel was built under the direction of the Chief Civil Engineer of the Eastern Region of British Railways, Mr. J. I. Campbell, the consulting engineers being Sir William Halcrow and Partners, and the contractor Balfour Beatty and Co., Ltd. The opening ceremony was followed by a luncheon at Sheffield. Sir Brian Robertson, chairman of the British Transport Commission, was in the chair, and a toast to "The Civil Engineers and Contractors" was proposed by Mr. J. W. Watkins, Chief Regional Manager of the London Midland Region of British Railways. Mr. J. I. Campbell, Sir William Halcrow and Mr. H. Balfour each made a speech in reply. A vote of thanks to the Minister was proposed by Mr. C. K. Bird, Chief Regional Manager of the Eastern Region, and Mr. Lennox-Boyd responded. Finally, Mr. P. Scott, of Sir William Halcrow and Partners, proposed a toast to the Railway Executive, and Sir Brian Robertson replied.

### Institution of Metallurgists

IN his recent presidential address to the Institution of Metallurgists, Mr. W. Barr said that the membership of the Institution continued to grow at a steady rate of about 200 a year and that there was no sign of decline. The Institution's aim was to include in the various grades of membership all those who were qualified metallurgists, using the latter term widely enough to include any who contributed in any way to the science or practice of metallurgy. He said also that entry into membership by way of the Institution's examination was being sought in increasing measure and that for the current year the registered applications numbered more than 300, which he thought was very satisfactory. Mr. Barr then referred to applicants for membership who sought partial or total exemption from the Institution's examinations. In the case of those submitting metallurgical qualifications awarded by universities, the granting of exemption was provided for in the regulations. Certain other certificates were also acceptable, he said, but there still remained a number of diplomas, the standards of which had yet to be ascertained in relation to known standard examinations or to the Institution's examination. A new Board of Metallurgical Studies and Examinations had been set up jointly by the Institution of Metallurgists and the Institution of Mining and Metallurgy. The membership of that board, Mr. Barr explained, represented many metallurgical interests, and the board was now engaged on a review of the standards and requirements of different metallurgical examinations.

### Colliery Management

ON Friday last, Mr. E. H. Browne, director-general of production to the National Coal Board, addressed the annual conference of the National Association of Colliery Managers on the subject of colliery management. He emphasised, during his address, the need for a change in the concept of the management of collieries. Mr. Browne said that coal mining in this country was once a natural art or craft. To-day, however, it involved the use of an enormous variety of engineering techniques, from roof control to multi-rope winding, from methane drainage to froth flotation of fine coal. There was urgent need, he thought, to increase efficiency in the pits as they stood at the moment, with little, if any, physical change or capital expenditure, by improving day-to-day organisation, the deployment of men, and the control of operations generally. Mr. Browne went on to talk of the enormous amount of necessary work to be done by minor changes in transport, at loading points and pit bottoms and on the surface. In addition, he said, the mechanisation of coalface operations called for more pioneering work, and, when established, it needed more detailed management, better plant maintenance, and more engineering skill if the proper results were to be obtained from it. To manage the coal industry efficiently and to reconstruct it, Mr. Browne continued, called for the development of strong lateral branches of technical control, for the building up of a strong planning organisation, the strengthening of service departments, and for the establishment of specialist services in the field of mining itself. Those developments, however, Mr. Browne said, were not enough in themselves, and though they would relieve the colliery manager greatly in some ways, they would make his work more complicated in others and would demand the full exercise of his powers of co-ordination.

### Institution of Mechanical Engineers Act, 1954

THE council of the Institution of Mechanical Engineers has announced that the Institution of Mechanical Engineers Bill, which was introduced into Parliament earlier this year, has recently received the Royal Assent. The Bill was promoted because some corporate members of the Institution had expressed doubts concerning the correctness of certain procedures followed in the past. The council decided last year to take steps to remove any existing doubts and was advised that the best way to do so was by Act of Parliament. Accordingly, a resolution was carried by a general meeting of corporate members of the Institution proposing the promotion of "A Bill for the removal of doubts as to the validity of the amalgamation of the Institution of Automobile Engineers with the Institution of Mechanical Engineers and as to the validity of the subscriptions payable to the Institution of Mechanical Engineers; and for other purposes. . . ." The Bill received its first reading in the House of Commons on February 2nd, passed through its second and third reading stages, and was sent to the House of Lords on March 22nd.

### Kelvin Medal Presentation

AT a meeting which was held in the hall of the Institution of Mechanical Engineers in London on Wednesday of last week, the Kelvin Medal for 1953 was presented to Dr. Chalmers Jack Mackenzie, C.M.G., F.R.S. The president of the Institution of Civil Engineers, Mr. W. P. Shepherd-Barron, was in the chair and the presentation was made by Field-Marshal Earl Alexander of Tunis, K.G. Dr. Mackenzie, who is the president of the Atomic Energy Control Board of Canada, was born in New Brunswick in 1888 and studied at Dalhousie University and Harvard University. During the first world war he served with the 54th Canadian Infantry Battalion. From 1918 to 1939 Dr. Mackenzie was Professor of Civil Engineering at the University of Saskatchewan and for the greater part of that period was also Dean of the College of Engineering. Dr. Mackenzie was appointed president of the National Research Council of Canada in 1939, an office which he occupied until 1952, when he became president of Atomic Energy of Canada, Ltd. He was appointed to the Atomic Energy Control Board in 1946 and has been president of the Board since 1948. The Kelvin Medal was created to commemorate the work done by the late Lord Kelvin, and is awarded triennially as a mark of distinction to engineers and scientists whose work is of a kind with which Lord Kelvin was identified. The Kelvin medal fund is administered by the Institution of Civil Engineers, each award being made by a committee, consisting of the presidents of the leading British engineering institutions, which considers recommendations from similar institutions in all parts of the world. After the presentation last week, Dr. Mackenzie delivered a lecture entitled "The National Significance of Two Decades of Engineering Research in Canada."

# Some Recent Swiss Hydro-Electric Schemes

No. VIII—(*Continued from page 807, June 4th*)

*Our account of the Birsfelden scheme on the River Rhine concludes with a description of the barrage and power station. The alternators and the sluice gates are of original design, and scour-resistant concrete has been used in the construction of the sill of the barrage.*

TYPICAL cross-sectional drawings of the barrage and the power station at Birsfelden are shown in Fig. 35. The architecture of the power station is not without interest. The building is of reinforced concrete ; the upstream facade consists of a number of massive Y-shaped column elements, which (as Fig. 36 shows) are rather widely spaced and carry the crane beam (which is also of reinforced concrete) and the power station roof. The roof is of shell construction and is 15cm to 45cm thick. As will be seen from the impression a very clean line has thus been given to the power station, and the alternators will be visible through the large area of glass which will form the cladding between the reinforced concrete columns. The crane beam and travelling crane will also be visible, thus emphasising the " functional " basis of this design. Considerable trouble has also been taken with the appearance of the various other elements of the project. The " island " between the navigation canal and the power station will be planted with trees, and the central pier between the power station and the barrage has been made large enough for one or two trees to be planted on it. The barrage itself has a clean appearance, with the low unbroken horizontal line of the upstream bridge accented by the five winch houses spaced along it. From the architectural point of view, therefore, Birsfelden power station breaks away from the normal style prevailing in Switzerland to-day, a typical example of which is the power station of the Wildegg-Brugg scheme illustrated in Fig. 25 (*ante*).

The turbo-alternator sets are, physically, amongst the largest in Europe, for, as we have already indicated, the head is low and the flow large (7m and 325 cumecs respectively). The diameter of the turbine runners is 7·2m and the inner diameter of the stator of the alternators is 11·5m. The machines will generate 28·6MVA at 6·6kV and 68 r.p.m. The load on the thrust bearing of each machine will be 900 tons.

Two of the alternators are being made by the Oerlikon Engineering Works in Zurich ; they will embody some novel ideas including an arrangement whereby the exciting current will be produced quite independently of outside sources of power. Under the terms of the Swiss-German agreement on the utilisation of hydro-electric power at Birsfelden, two further generators are being built to nearly identical specifications by Siemens-Schuckert in Mülheim, Germany. All four generators will be built from a common design which, apart from general construction, outward appearance and external dimensions, will also provide for the incorporation of identical windings, pole clampings, current lead-in and lead-out connections of rotors and stators.

The alternators are of the " umbrella " form, the revolving field being overhung above the upper turbine bearing at the end of the turbine shaft. The shaft is hollow and the end is enlarged to form the cylinder of the servo-motor, which, through the hollow shaft, allows the vanes of the Kaplan turbine to feather. Consequently, the generators have neither a shaft of their own nor a bearing. Cooling of the generators is effected in a closed air circuit by water coolers fitted to the outer wall of the housing, air circulation ducts being provided in the machine ; in winter heat is supplied to the machine room.

The alternators, which are at present under construction, have the following specifications :—

| | |
|---|---|
| Output per alternator | 26 to 28·6MVA |
| Speed | 68 r.p.m. |
| Runaway speed | 180 r.p.m. |
| Voltage | 6600V + 10 per cent |
| Frequency | 50 c/s |
| Available moment of gyration | $\omega R^2$ 118,000 lb/ft² |
| Weight of generator (with accessories) | 400 tons |
| Outside diameter of hot-air mantle | 46ft |
| Outside diameter of housing | 41·8ft |

The stator housing, made of welded steel plates, is in four parts to facilitate transport. The armature iron consists, in the conventional way, of pressed segments of electrical sheet steel with small hysteresis and eddy current loss. The sheet-steel segments are arranged in layers according to a system which makes due allowance for the large diameter and the relatively small radial thickness. This sheet-steel member is firmly pressed with press plates and press fingers (for the teeth) by means of steel screws, and then secured to the housing. There are more than 750 open slots which take the stator winding which consists of half-coils forming a " grid " winding with two conductors per slot and mica insulation. The coil ends are mechanically supported by adjustable supports.

The revolving field comprises a cast steel boss, arms, rim and salient poles. In the Oerlikon generators the arms of the rotor spider are made of cast steel, while in the Siemens machines welded steel plates are used. The rotor rim is a ring consisting of sheet-steel segments with fitted steel bolts. The eighty-eight magnet poles are secured in this rotor rim by swallow-tailed claws. If the governor should fail a runaway speed of 180 r.p.m. would be reached. The centrifugal force of the poles and the rim itself produce a force of 10·34 million pounds with respect to the cross-section. The rotor rim will be assembled on site and the rim will be heated and shrunk on to the rotor spider. The individual poles consist of sheet-steel plates riveted together and fitted with a damper winding. Both pole and pole coil form a unit that can be removed together. Each pole can be drawn out of the generator axially, upwards or downwards.

The excitation current for the pole coils is produced in a novel way (see Fig. 37). Each main alternator *F* has a separate converter group consisting of a three-phase motor *A*, a main exciter *B*, and self-excited auxiliary exciter *C* for exciting the main exciter. However, in order to be independent of outside sources of power, this three-phase motor is fed by an auxiliary alternator *D* mounted on the shaft of the main alternator. The auxiliary alternator also requires a direct-current excitation to the extent of about 20kW taken from the auxiliary exciter *E*, which is geared to the main shaft and whose pole consists of permanent magnets, thus requiring no direct current for excitation. This arrangement is required by the low speed of the main generator. The converter group has a higher speed and, as a result, is not only smaller and cheaper, but can be built so as to be more quickly regulated. It has the advantage that no accumulator batteries or rectifiers are needed. Moreover, it requires neither action on the part of the operating staff nor switchover operations. When the main alternator starts up the auxiliary alternator *D* is excited at roughly 45 per cent of the rated speed of the alternator, and takes along with it the converter group, whose motor is provided with a squirrel-cage rotor. The main excitation thus starts automatically ; it is independent and self-contained. The auxiliary generator *E* with its permanent magnet is also equipped with three slip rings for supplying three-phase current to feed the pendulum motor of the speed governor.

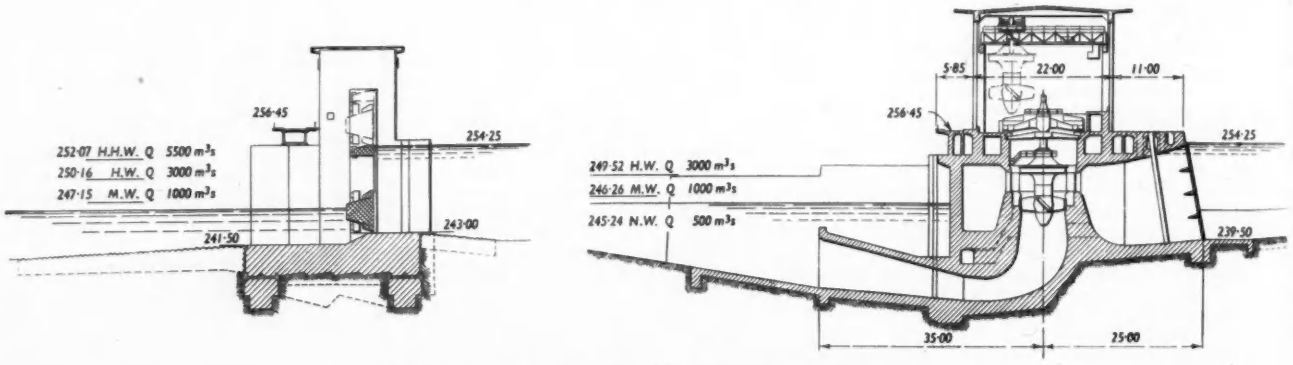



**Fig. 35—Cross sections of Birsfelden barrage and power stations**

## The Barrage

The five 27m bays of the barrage will be able, when complete, to pass a flood of

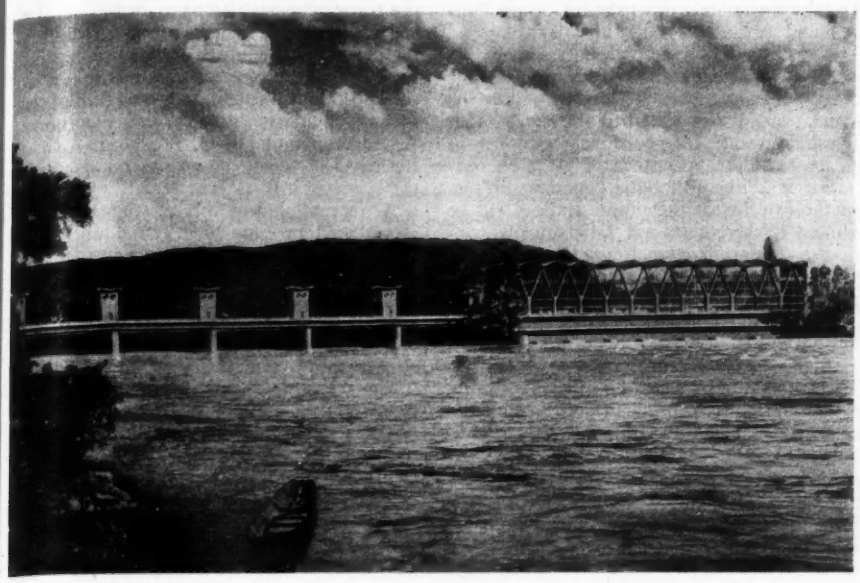


**Fig. 36—Artist's impression of completed barrage and power station**

5500 cumecs, without an increase in the reservoir level. The sluice gates are of a new kind—called "Rollhaken Schülze"—and are shown in the cross-sectional illustration Fig. 35. There is to be a pair of gates in each bay, each gate spanning the full 27m and each pair closing the depth of 11·25m between the sill and the top water level. The lower gate is of substantial construction, in the form of a box beam spanning horizontally across the opening, as shown cross-hatched in the lower part of the cross-section ; it is 5·5m in height. The upper gate consists of a steel plate skin, which bears on the lower gate along its bottom edge (when the two gates are in the "closed" position) and is stiffened by a beam along its top edge. This beam is also shown cross-hatched in Fig. 35, and it also serves to throw the stream of water spilling over the gate clear of the gate installation. The upper gate may be lowered, its skin plate sliding over the face of the lower gate, shown dotted in Fig. 35, and also in Fig. 38. Electrically powered winches are installed in the houses on each pier, to operate the gates.

The gates are principally of welded construction, but riveting was used for some of the work. In calculating the loads acting on them, the full hydrostatic pressure was considered to act on the upstream side (i.e. a head of 11·75m) plus an allowance of 0·5m for waves, a maximum vertical load of 34 tons on the upper gate and an allowance of 30 tons to cover the possibility of the gate being rammed by a ship. The main structural members are of steel of two qualities, with specified ultimate tensile strengths of 40/45 kg per square millimetre and 37/45 kg per square millimètre respectively. An extensive programme of tests was carried out in the early stages of design when the final form of the gates was being evolved, and during construction careful control of the quality of the work was achieved, with comprehensive metallurgical tests and site testing of welds by X-ray, gamma-ray and ultrasonic methods.

Cast steel rails are built into the piers of the barrage to transmit the hydrostatic loads from the gates. The upper gate has a pair of cast steel wheels, running in bronze bearings, situated at each side of the gate and transmitting load from the beam at the top of the gate. The lower part of the gate transmits its load, through rollers, to the face of the lower gate. The load on the lower gate is taken centrally on each side to two pairs of wheels (see Fig. 38). The maximum load on each wheel amounts to 240 tons, and the wheels are 90cm in diameter with a useful width of 25cm ; these wheels have roller bearings, to reduce frictional forces and hence the load on the lifting gear, and run on the same guide rails as the upper gate.

Watertightness of the gates is ensured by profiled rubber sealing strips of American manufacture, which can be adjusted from time to time, to keep leakage losses to a minimum. The meeting faces of the lower gates and the sill are, however, sealed by oak timbers, which are toothed to prevent vibration with small gate openings. The calculation of the power required for lifting the gates was influenced by the hook-shaped spill weir beam of the upper gate, the lifting load amounting to $2\times80$ tons for the upper gate and $2\times93$ tons for the lower one.

The gates are being constructed *in situ*, supported on a service bridge, just above the top water level of the Rhine (Fig. 38). Protection of the gates from corrosion involves sand blasting and zinc spraying to give a 2mm coating of zinc, and then painting with three coats of a newly devised paint developed in Germany—"Polycyanat-Lack," which, under test has, we are told, exhibited very resistant properties to attack from heat, frost, acid, and infra-red light. On completing the assembly of a pair of gates the service bridge is dismantled and moved to the next span and the gates lowered on to the sill. The gates were designed and manufactured by Buss. A.G., of Basle, and the lifting gear was

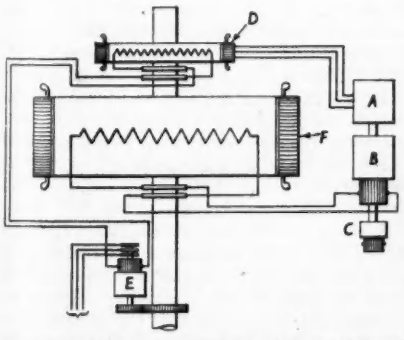



**Fig. 37—Independent excitation system for 26MVA alternators of Birsfelden power station**

quickly in case of emergency, at a rate of 15cm a second for a total depth of 4·5m. Should one of the generators in the power station be thrown off load suddenly, then one of the upper gates will be automatically lowered, to discharge the rated flow of the turbine. Thus disturbed, flow in the river due to sudden changes in the power station load, is avoided. Some precaution such as this must always be taken in a combined power and navigation project.

The lower gate may also be raised behind the upper one, and the two gates lifted clear of the top water level, as they are

**Fig. 38—Birsfelden barrage power station and lock showing constructional progress in April**

supplied by Maschinenfabrik Augsburg-Nürnburg and Eisenbau Wyhlen A.G., to the specifications of Buss. A.G.

### Concrete Testing

The use of concrete for the sill of the barrage is an innovation for a Swiss power station on a swift-flowing river such as the Rhine. As a measure of scour protection, granite blocks have been used hitherto to face the sill of such a barrage. The properties of the concrete used in this case have been studied at a concrete laboratory on the site. A scour testing machine has been developed for this purpose; it consists essentially of a large drum which is rotated with stones and water in it, which abrade the surface of test specimens. The drum is 50cm wide and four test slabs are fitted into its circumference, equally spaced, each slab being 50cm by 50cm in size and 15cm thick. Thus four 50cm by 50cm surfaces are exposed

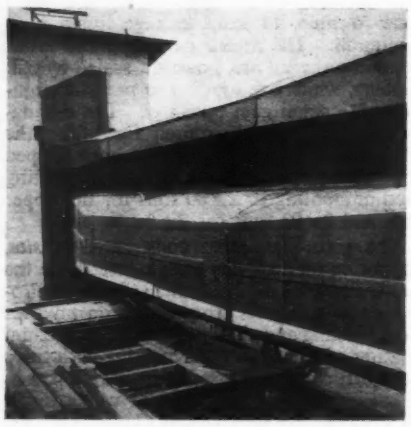


**Fig. 39—Double sluice gates of barrage in raised position with service bridge below them**

as part of the periphery of the interior of the drum, which is approximately 75cm in diameter, the distance between diametrically opposite slabs. The drum is then rotated at 30 r.p.m. for twenty-four hours, with 10 kg of stones of mixed sizes and 25 litres of water churning about inside it. When the test slabs are removed they show saucer-like depressions close to their "leading edge" (with respect to the direction of rotation), the size of depression indicating the vulnerability of the material of the slab to scour. Extensive tests have been carried out with this machine; the blocks tested have included ones of granite and of concrete mixes of various kinds. For instance, iron powder is sometimes added to concrete to give a good wear-resisting surface, and a concrete with such an addition was one of those tested. It was found, however, that the best results were obtained with what is conventionally regarded as a good-quality concrete, namely, a concrete mix with 350 kg of Portland cement per cubic metre and a water/cement ratio of 0·4. A wetting agent ("Plastiment") was added to the extent of 1 per cent of the weight of cement, and, of course, the concrete was carefully vibrated. Such a concrete gave twenty-eight-day compressive strengths of about 500 kg per square centimetre and was used to build the sill of the barrage. Elsewhere in the work the concrete employed has a cement content of 300 kg of Portland cement per cubic metre and a water/cement ratio of 0·5, and gives twenty-eight-day compression strengths of about 400 kg per square centimetre. Scour protection of the barrage has also included the emplacement of 1m cubes of concrete to form rip-rap immediately downstream of the barrage and in the power station tail-race.

The work of the concrete laboratory also includes the usual routine tests to check the quality of constructional work as well as the scour investigation described above. Another investigation at present in progress concerns the quality and appearance of paint on concrete. It is likely that the concrete surfaces on the exterior of the power station will be painted if these tests are satisfactorily concluded. Apart from painting, however, the board marks of the shuttering are left untreated to form the finished surface.

It is expected that the Birsfelden power station will be in partial operation, with the barrage and navigation lock completed, this year, after four and a half years of construction. The cost of the project is estimated at about 112½ million francs, with an additional 23,750,000 francs for the lock and canal, based on 1948 prices. Excavation will total about 2,000,000 cubic metres, and some 250,000 cubic metres of concrete will have to be placed to complete the various power and navigation structures. Unlike the other schemes described in this series of articles, each of which has been designed by the staff of the power company concerned, the Birsfelden project has been designed, and the construction supervised, by a firm of consulting engineers, namely, Ingenieurbureau A. Aegerter and Dr. O. Bosshardt A.G., of Basle. The power company in this case is the Kraftwerk Birsfelden A.G.

A recent photograph of the scheme is reproduced in Fig. 39. The double sluice gates of the barrage are shown in the raised position in three of the bays, and the work is sufficiently advanced to give an idea of the appearance of the power station. The large cofferdam enclosing the power station is clearly shown and the ends of the draught tubes are visible. Various items of constructional plant can be seen between the power station and the lock, and, as may be observed, construction of the lock walls is well advanced. The aggregate and concrete plant for construction of the lock may be seen in the background, behind the lock, with Birsfelden quay still further in the background.

*(To be continued)*

# French Locomotive Experiences

By EDWARD H. LIVESAY

(*Concluded from page* 811, *June 4th*)

## No. XII—"THE GOLDEN ARROW," PARIS TO LONDON, AND SOME COMMENTS ON WHAT WAS SEEN ON THE S.N.C.F.

THE very interesting month spent in France, during which I rode on so many fine locomotives, ended with a return from Paris to Calais on the "Golden Arrow," hauled again, as it had been before, by a Chapelon "Pacific," No. 231-E48. I was glad to make the run in the reverse direction for several reasons, one being that in the interim I had travelled many hundreds of miles on Chapelon engines, and so had become more familiar with them and their handling than was the case on arrival in France, which might result in my noticing things that I had missed a month earlier. Unfortunately, my good friend, Inspector Fillon, was not able to be with me, his duties making it impossible, and there was no interpreter to take his place. The executive of the S.N.C.F. probably thought that by this time I ought to be able to get along without assistance—or even have learned French! The first supposition contained some truth, but not the latter; however, Monsieur Hugôt, who had driven the three-cylinder simple "Pacific" "R1" to Aulnoye for me, and "Pacifics" from there to Lille and Paris, as described in Article VIII, had been told off to drive me back to Calais, and though his English was about on a par with my French, I did not feel entirely deserted—there was still a friend at hand.

Paris wept at my departure, and with very little encouragement I could have mingled my tears with hers. The engine was of the same type as No. 231-E16, so the picture, drawings and particulars associated with the latter, given in Article I, will be equally applicable to No. 231-E48. The north-bound "Golden Arrow" left the Gare du Nord punctually at 12.30 p.m., in heavy rain, the load being about 450 tons; there was, of course, no slipping and acceleration was rapid on the declivity to St. Denis. The long climb up the Survilliers bank was begun at 65 m.p.h., and the speed did not fall below 55 m.p.h. right to the summit. It looked to me like three-quarter regulator, cut-off 40 per cent h.p., and the ratio of h.p. to l.p. steam chest pressures was as 14/3½ hpz—say, 206/51 lb. Though this engine was getting on in years, as are all the Chapelon "Pacifics," it was in perfect condition, riding beautifully, with not a sound of any faults at the front end. By this time I had come to expect this in France—it was the rule throughout the tour. Due to the rain on the front window I missed the top of the Survilliers bank, now familiar ground, but Orry la Ville, a little way down the northern side, was passed at 12.54 p.m., 22 miles in 24 min, average 55 m.p.h. Descending, at 75 m.p.h., the pressures were as 4/½, the regulator being one-third open, so the l.p. cylinders were practically out of action.

This matter of respective pressures and cut-offs with Chapelon engines, of course, interests British observers, and I asked Fillon, who knows what he is talking about, for definite rulings. His reply—which is in writing, and beside me—is to the effect that on 1 in 200 (which will do very well for the Survilliers bank, and possibly he was using it as an example), with a 500-ton load (near enough to the "Golden Arrow's" 450 tons above), at constant speed 58 m.p.h., the h.p. cut-off would be 38/40 per cent and the l.p. 45 per cent, the steam chest pressures 216/58 lb, respectively, with boiler pressure 247. All this comes very close to what I observed on this return run to Calais with Hugôt at the regulator—which, incidentally, was generally about three-quarters when the engine was pulling—and satisfies *me*, at any rate! The 247 lb boiler pressure given by Fillon is that of these "Pacifics," from which it follows that if the h.p. cylinders are only getting steam at 216, then the regulator may be assumed as about three-quarters open, or the steam chest figure would be considerably higher than this, the perfection of front-end design of Chapelon engines being what it is; it was three-quarters on this occasion. Why it wasn't full,

(it seldom was so far as my observations went), I cannot say, as I forgot to ask—or have forgotten the answer! Theoretically, full regulator should be used on h.p. compound engines; actually it seldom was; I really must find out about this. But we are coming down from Survilliers.

Chantilly, 12.58 p.m., and the ritual slow for the Canardière Viaduct; here the rain ceased and Creil was run through at reduced speed, 1·03 p.m., 31 miles in 33 min. Steam was always well up; so much so that the firedoor was opened once or twice to check an impending job for the safety valves —which I have always understood is bad for the tubes. The fireman did not have a very hard time, but still had little opportunity to gaze at the scenery; I did this

Fig. 58—Engine No. 70004 "William Shakespeare" and the "Golden Arrow" near Sandling Junction

for him. Once more I admired that inward-swinging firedoor; it seems a thoroughly sensible arrangement.

Avrechy, 12·16 p.m., 45 miles in 46 min, a typical average for the French "Golden Arrow." At Breteuil the sun came out, and a slack followed for single-line operation; there was a track-laying machine on the other ("up" to Paris) metals. Nobody in the cab speaking English, I was a little in the dark sometimes as to what exactly was happening, but I gathered we were a trifle late, due to the slacks. Another followed, for a small bridge repair job nearing Ailly-sur-Noye, 1.42 p.m.; 69 miles in 72 min. At Amiens we were 3 min late and speeding up; Abbeville 2.18 p.m., 109 miles in 108 min—the average was in the sixties.

It had been a pleasant run right from the start, in spite of the fact that by this time I was wet to the knees, and my shoes were full of water. The watering-hose connection was leaking, and the wind flirted with the spray, blowing it about on my—the fireman's—side of the footplate, besides making a nasty mess underfoot. The fireman tried in vain to fix it, by tying rags round the pipe, but this did not do much good, and finally, with resigned shrugs and the raising of eyebrows, he waved me to his place close up to the front window, as he thought, out of the shower. Out of the frying pan into the fire—the A.C.F.I. lubricator on the back plate was leaking, too, every pulsation propelling a little jet of condensate in my direction; I was sprayed front and back, getting it coming and going. I thought of what would happen at Calais—they would send me straight to the stokehold of the "Invicta"—nobody would believe I had a first-class ticket. Then suddenly it struck me—I hadn't got any ticket at all, as in planning the two ends of the journey I had forgotten the middle! It was disastrous; I should certainly end up in the stokehold, or even might not be allowed on board at all. However, time enough to bother about trouble at Calais—the immediate problem was to avoid being drowned in the cab before I got there. It was solved by transference to Hugôt's side, in the hope the wind would dry at any rate some of my sopping accoutrements, though it could not wash me, too. But nothing really mattered; it was a joy to be on this engine, running so sweetly, the only sad thing being that it was taking me away from France.

Passing Etaples, near the foot of the heavy climb that begins with 1 in 200 and ends at Dannes-Camiers after 3 miles of 1 in 143, the speed was 62 m.p.h., h.p. cut-off 40 per cent, regulator three-quarters open, pressures 15/2½; on the stiffest part near the summit the speed was 55 m.p.h., cut-off still 40 per cent, pressures 16/3 plus, so evidently the regulator was now full open, and the working was still compound, unreinforced. This brings up the matter of reinforced compound operation; no doubt it can be used, but it must be very seldom done, as I never noticed it on any runs. There are several ways these Chapelon engines can be worked, but save in exceptional circumstances it was generally a case of h.p. steam in all four cylinders at starting, followed by simple compound working afterwards, if the Hibernianism be allowed; it is unnecessary to go into complicated improbabilities. Moreover, independent regulation of the two sets of valve gears is outmoded on French locomotives, the latest types having the h.p. and l.p. gears at a fixed ratio, so why thresh old straw? With independent operation it was probably found that even the highly skilled, super-educated *mécaniciens* we used to hear of did not always trouble to play symphonies on the cut-off scales, and a reasonably correct fixed ratio gave better results in the long run. After all, French locomotives are not always driven by Leseigneurs and Hugôts—only when important people are in the cab!

Another generally accepted delusion can go into the discard, too—those briquettes. They were often in position on the tender, but only once did I see them used out on the road, and I understand they seldom are, only when firing up or in stations, and presumably in emergency. They were stacked on No. 231-E48's tender, too, where they were more ornamental than useful, helping in conjunction with the leaking watering-hose to make a mess of the footplate—and to make a mess of me, too. French coal, except when screened for mechanical stoking, is apt to be very dusty, which accounts for the delightfully dirty state of many French cabs—which, personally, I rather enjoy. It takes me back to boyhood; the dirtier I was then, the happier. It was a lovely summer afternoon now, the country looking its best after the drenching earlier in the day. Boulogne was passed through at 3.05 p.m., 158 miles in 155 min, and the sea came into sight, bringing a pointed gesture from Hugôt—"Angleterre!" Somehow this did not make me feel very joyful; I looked at the "white cliffs of Dover" with mixed feelings—the month on the S.N.C.F. was nearly over. Fine, open country here, wind-swept and invigorating; up the Caffiers bank, 1 in 125, beginning at 60 m.p.h., the speed falling to 45 m.p.h. at the summit, with steam chest readings 16/3½ hpz. And so down into Calais, to a stand in the Marine Station 3.41, 3 min early; 186 miles in 191 min, 58·4 m.p.h. A fine run, flawless from an operational point of view, though a trifle damp physically. The French ideal had been adhered to—a high average with a moderate maximum, in this case about 75 m.p.h. Except for two leakage trivia in the cab, the condition and running of No. 231-E48 were perfect, though it was fifteen years old, having been built at Fives-Lille in 1937, and happened to be the last of the class.

The work done by these "Pacifics" has been remarkable, bearing in mind they are not really big engines, only weighing a little over 100 tons, and with but 57 tons available for adhesion. An example of what they can do in emergency has been given me by Monsieur Fillon. On March 12, 1953, train No. 356, connecting with the Dover–Dunkirk ferry sleeping-car service, headed by No. 231-E24 (La Chapelle shed), consisting of eleven coaches weighing 539 tons, left Dunkirk 47 min late, fog in the Channel having delayed the boat's arrival. It made up 37 min *en route* to Paris, covering the 197 miles non-stop in 3 h, at an average of 65·7 m.p.h., notwithstanding the following delays:—(1) Bergues (5m from Dunkirk), a restriction to 30 m.p.h. for a bridge repair; (2) Hazebrouck, restriction 25 m.p.h. for a facing switch repair; (3) Echierres (8m from Hazebrouck), restriction 40 m.p.h. for bridge repair; (4) Lens, restriction 30 m.p.h. for relaying. Fillon explains that normally the working schedule of this train is easy to keep, allowing time to be made up when the schedule is upset due to late arrival of the boat, as in this case.

At Calais, where, as anticipated, I arrived in a state of indescribable filth, my equanimity was further shattered by an official photographer taking a flash bulb picture of the three of us beside the engine, which I thought rather a dirty trick to play on an already sufficiently embarrassed and dirty individual. After saying good-bye to Monsieur Hugôt and the fireman—there had been no "spare *mécanicien*" standing by during this run—and thanking them for making my last journey so pleasant—yes, *pleasant*—and congratulating them in my best French, God save the mark, on their handling of the engine, I proceeded on board, the ship's people at the gangway being too spellbound at my appearance to think of asking me for the missing ticket, much to my relief, as any additional hiatus in public would only have added to the inferiority complex under which I was

labouring. I looked and was treated as an "Untouchable," the passengers falling back respectfully on either side as I wended my way to the purser's office. He, good man, having evidently been instructed from London as to what would be advisable, took me to a cabin and shut me in; I breathed again and relaxed. Later, I washed, somewhat superficially—a complete cleansing would have had to be more in the nature of excavation. After all, what was the good? I should only accumulate another layer of grime between Dover and London—prinking would be love's labour lost. So ended this unforgettable month spent on the wonderful engines of the S.N.C.F., an experience begun with qualms which turned out to be merely the baseless fabric of a dream, every hour of which I had enjoyed, and which had led, I felt, to the making of a hundred friends and not one enemy—and to this series of articles.

The "Golden Arrow" left Dover at 6.17 p.m., slightly late, in weather sunny, but with a slight intermittent sea drizzle; the engine was again the standard "Pacific" No. 70004, "William Shakespeare," the load the usual 400 tons, and the enginemen Grant and Wells, of Dover. There was a slight initial slip; the cab seemed altogether different from the French type, and as a matter of fact was; large, clean, very neat, with substantial seats, Wells immediately offering me his—accepted. Really, it was nice to be back in England again, in familiar surroundings, with my own people, and to be able to talk without embarrassment on either side! Little homely touches were quite affecting—such as a slight leak from the right-hand piston-rod gland! The top of the long rise to Westenhanger was passed at 6.38 p.m., making 50 m.p.h.—about; no Flaman to ensure accuracy—13 miles, 21 min, 39 m.p.h. Down the opposite side the speed rose to 70 m.p.h.; the riding was good, but totally different from the French engines; it was hard, harsh, as if the springs were stiff, with none of the easy, shockless action the rule across the Channel. Ashford, passed at 70 m.p.h. and 6.45 p.m.; Pluckley 6.50 p.m., in April weather, though it was August—sun and shower alternating, cool and pleasant. The "gland leak," I was told, might be a cylinder cock; these are steam operated. The cab seemed roomier than those I had been in recently, though it was no wider; the boiler head was less cluttered with fittings, and there were fewer refinements of indication and control. Comfort was certainly greater than in France, and safety, too—solid handrails and doors, tight catches, and the footplate extending right to the back without a tender section felt very good—certainly I like that. One simply could not fall out of "William Shakespeare's" cab; one could do the disappearing trick easily enough from a Chapelon "Pacific." There is good locker accommodation, too, on British engines, often lacking in France. I like the "Britannias—which, I am sure, Mr. Riddles will be relieved to hear—though he might countersink the rivets in the floor, so they won't catch the fireman's shovel when he is "scraping-up"—firemen do use such unfortunate language at times over little things like that; it quite shocks me. And that draught—something really ought to be done about that, too. Lumbago is a nasty thing, and not only firemen, but drivers, sometimes use language about it, which in their calmer moments no doubt they regret.

Just beyond Tonbridge there was a slow to 30 m.p.h.—the actual restriction was 50 m.p.h., I believe—and on the succeeding very heavy 6-mile climb through Hildenborough to Sevenoaks, 1 in 122, the speed never rose above 35 m.p.h., with full regulator and 30 per cent cut-off. The scale on "Standards" is a pleasure to consult; plain, big figures on a drum, the best I have ever seen, an observer's joy, particularly an observer who is always consulting them because he can't think of anything else to observe. But the reverse mechanism on "Standards" can be very hard to operate, as one driver demonstrated to me—and made me demonstrate to him—his expressions being quite deplorable. Mine, though naturally couched in somewhat more guarded terms, came to much the same thing—something should be done about *that*.

Sevenoaks, 7.20 p.m.; the 6-mile climb had taken 11 min; then a sharp 2-mile drop at 1 in 160 to Dunton Green, followed by a 3½-mile climb, mostly at 1 in 143 or thereabouts, through Polhill tunnel to Knockholt; a restriction to 15 m.p.h., and then almost uninterruptedly steeply down for 9 miles to Kent House, with all the really hard work over and done with. Wells could, and did, relax, though he had not been actually overworked anywhere—"Britannias" are good steamers. He said he liked them, though he still had a soft spot in his heart for the Bulleid "Pacifics," which also, he said, were good engines, and he had not found them hard. It is amusing for anyone doing much footplate travel to hear the diametrically opposite opinions of a certain class of engine advanced by different enginemen; they are apt to be as the Poles asunder. You should never accept the views of one or two men; at least a dozen should be consulted; you will generally find them about 50/50, and yourself back where you started.

We were doing well at Orpington, passed at 7.31 p.m., 63 miles in 74 min, 51 m.p.h., but at Bickley the run went to pieces. First came a signal slowing down to walking pace, followed by a dead stop; an electric train ahead had broken in two, and had to be got out of the way. Heavy Saturday afternoon traffic further complicated things, resulting in arrival at Victoria 8.07 p.m., which I was told was 16 min late—I have not consulted a time-table. The verdict was: 77 miles from Dover in 110 min, 42 m.p.h. One cannot get really excited over that, of course, but it was in no way the engine's fault—or anyone's, I suppose. A very difficult route, unsuitable for high average speed, plus traffic hindrances, were responsible. Much better could be done, say, as far as Orpington, but the journey is so short that only a few minutes would be saved in any case, so it is probably not worth while. There was no complaint to make about the engine, anyway; it had steamed and behaved well, and had done all that was asked of it. I repeat, I like the "Britannias."

A précis of the two "Golden Arrow" runs, from London to Paris and return, works out as follows:—

| | Min | M.p.h. | Min late |
|---|---|---|---|
| Victoria/Dover, 77 miles non-stop | 96 | 48 | 4 |
| Dover/Victoria, 77 miles, one stop (signal) | 110 | 42 | 16 |
| | | | Min Early |
| Calais/Paris, 186 miles, non-stop | 196 | 57 | 2 |
| Paris/Calais, 186 miles, non-stop | 191 | 58·4 | 3 |

At Victoria, not even yet surfeited with locomotives, I waited for a steam train to Croydon—electrics are useful and sometimes faster, but they do not interest me so much. On going to the front end to see what sort of engine was on, the crew were discovered to be old acquaintances, with whom I had ridden only recently. The driver turned to his mate: "Look 'oo's 'ere, Bill!"—and then to me: "Where've yer come from?" I said "Paris, on the 'Golden Arrow.'" He looked me up and down, and grinned. "Gorblimey, yer don't 'alf look filthy! Where was yer ridin'—in the smokebox?" I explained the why and wherefore, but got no sympathy. "Serves yer right—I told yer to keep away from them Frenchies—y're old enough to 'ave more sense!" Further mutual compliments having been exchanged, on my making a move in the direction of the train, he stopped me: "'Ere, you'd better come in with us—you ain't fit to go in the train like that—you'll muck up the blinkin' cushions! The guard'll chuck y'out!" Finding it impossible to refuse such a courteous invitation, so delicately phrased, if not exactly in the Queen's English, at any rate in impeccable Cockney, I accepted it, and the journey from Paris ended as it had begun, in a cab, a British one this time, roomy, clean and safe, one that I must admit was more comfortable than a Chapelon "Pacific's." The engine was a "P4" 2–6–4 tank, of which I am very fond, and can find no fault with whatever. No interpreter was needed here—we insulted and understood each other with facility—I was home again.

What were my conclusions about the French railways, their locomotives and equipment, based on long distances travelled in cab and train? I think the articles speak clearly enough; there is little need to gild the lily. Here I would like to emphasise again, as I did in the first article, that it was my aim to record good and bad impartially—that I was a faithful recorder, not a mere eulogiser. I have done so, recording things just as I saw them, and my desire to see the good did not warp my judgment, nor did I defer to the powers that be. When an engine did good work I have said so—and they all did. When little defects showed up, as they are sometimes sure to do in the best of engines, I have mentioned them—but how few there were! I saw good permanent way; any that was not, due to war-damage, deterioration during the occupation, or to natural wear and tear, was obviously being brought up to standard as rapidly as possible. The signalling system, with audible indication of "distants" in the cab, seemed very good indeed, and decidedly ahead of ours—except, of course, where this method has been adopted over certain stretches in Britain, unfortunately only a small percentage of the total track mileage. I do not know whether this system is universal in France; it was in operation over all the lines I came in contact with. The trains were clean and comfortable, and kept excellent time; of all those with which I was concerned, only one ran a minute or two late into the terminus, this being the local "pull-and-push" double-decker dealt with in Article V, destination the Gare du Nord, and that was only due to platform occupation bringing it to a stand momentarily outside. All the others were either on time or a minute or two early.

The stations, particularly the Parisian termini, were bright, clean and attractive; it was pleasant to be in them. So many British stations are—well, like many British stations! They may be attractive to some people, but it is certainly not because they are bright and clean; often it is only because there are locomotives in them, and some curious people like locomotives—I do, for instance—steam ones, at any rate. Look at ——— what a dingy, dreary, depressing, dirty dump! Yet I like it!

The engines I saw and rode in France—here again the articles tell the story of their design, work and condition. The sum of the latter, of all the machines on which I rode, can safely be put at about 95 per cent,

and this is no exaggeration—it was far higher than in Britain. The only one that brought the average down was the American "chain-gang" 2–8–2, and even that was doing fine work under difficulties, for which I give it high marks—only I hope to Goodness I never ride it again! If I am invited to do so I think I shall "report sick," as years ago I was told enginemen sometimes did when booked to work "Shires." They—the French engines—were evidently well looked after, and reasonably clean, though not as clean as the officials would like, for much the same reasons as in Britain. Enginemen seemed keen on their job, and anxious to get the best out of their machines; the bonuses given for fuel saving and time recovery may have their effect on this. They often have their own engine, though I do not know whether this is the rule; if so, it is a good one. Certainly they are quick-thinking and intelligent; whether more so than their British opposite numbers I would not like to say—for obvious reasons!

Though both French and British Railways are State-owned, there seems to be one important difference between them that may go a considerable way towards explaining the superiority I noticed in certain directions on the former. Apparently the French Government long ago ceased to try and make them pay, whereas in Britain, as we all know, we still struggle to keep ours out of the red, with more or less success. Last year I read in a British paper that the operation of the S.N.C.F. over the preceding twelve months had resulted in a deficit of £88,000,000. If B.R. were run regardless of loss, and were given a blank cheque every year by the Government, it would solve a good many problems! But it would not solve the major problem of British Railways, which does not concern finance at all, but labour, a problem which would only be intensified by unlimited funds. How the French solve it—if they have—I do not know; it was not in my programme to find out, the object of my visit being concerned more with locomotives than labour. Another factor operating to the benefit of the S.N.C.F. is the absence of more than a mere tithe of the road competition B.R. have to meet; however, all this is getting somewhat outside my province and the scope of these articles.

It will have been gathered that I was enthusiastic over much that I saw on French railways, and have made no secret of it—it was justified. What, then, it may be asked, did I find fault with? Nothing—or, at any rate, nothing of importance! If somebody will point out what I ought to have found fault with, and missed, I will sit corrected. I was perhaps a trifle critical of suburban trains, packed with passengers, running full speed with the doors open, but this is rather a minor matter—as officials pointed out, it is not allowed, and if people insist on committing suicide in this way it is their funeral. They added, "there is too much liberty in France, and not enough discipline." Maybe, but certainly the same thing applies to Britain—and Canada. One of my S.N.C.F. friends writes to me: "Everything is far from being perfect in France!" To which the same rejoinder is apropos. I am convinced we can learn a good deal from the French in railway matters; what they can learn from us I am at a loss to point out, though this may be mere ignorance on my part; somebody might point that out to me, too—and probably will.

But, after all, it was "the human angle" that made my experiences on the S.N.C.F. so extraordinarily pleasant—the invariable kindness and good fellowship I met with, the thoughtful consideration. I doubt whether things are quite so satisfactory in this regard on our side of the Channel. In conversation with an official of the S.N.C.F. who had been in England on railway business, and comparing his experiences with mine, I was struck by the difference—so little had been done for him, so much for me, and I was not even an official. I apologised to him on behalf of my country, pointing out that the British were not constitutionally cold and discourteous, merely thoughtless and shy! It takes time for the average Englishman to thaw, and to let himself go; some never do or can. Frenchmen are less afraid to do either, and I found that with very little encouragement it came natural to me, too. Hence my happiness in France!

I wish gratefully to acknowledge the unfailing courtesy and assistance extended to me by everyone with whom I came into contact on the S.N.C.F., which has left very pleasant memories. It is impossible to mention all individually, but exceptions must be made of Monsieur Armand, general manager, and Monsieur Parmantier, director of the department of material and traction, without whose co-operation the tour could not have been undertaken. To Monsieur Leseigneur, chief of traction, Nord Division, and Monsieur Hugôt, who drove outstanding engines on my behalf and to my admiration, my thanks are due, and to Monsieur Fillon, whose exposition of everything appertaining to the Nord Division, coupled with his admirable interpretation of it, I so much appreciated—to all these and many others I am grateful.

Coming to the department of design, I am under great obligations to Monsieur André Chapelon and his assistants, Monsieur Bohl and Monsieur Segaud, who chose the engines and runs dealt with in these articles, and who placed at my disposal all the technical data concerned with them. I did not have the pleasure of meeting Monsieur Chapelon, he being on holiday, but I hope to do so when I visit France again in the near future. The following letter received from Monsieur Chapelon is naturally gratifying, and I hope to implement the suggestion contained in it, as already stated:—"Cher Monsieur Livesay, a mon retour de congé, j'ai trouvé votre aimable lettre q'ui m'a causé le plus grand plaisir. Les paroles que vous voulez bien prononcer en ce qui concerne les satisfactions que vous avez éprouvées lors de votre voyage en France me touchent profondément. Je suis trés heureux que vous ayez pu voir ce qui vous intéressait, et suis particuliérement sensible á vos appreciations sur le fonctionnement de nos machines. J'espere bien que cette premiére prise de contact ne sera que le début de nos relations futures, et dans cet espoir, je vous prie de vouloir bien agréer, Cher Monsieur Livesay, l'assurance de mes sentiments les meilleurs et les plus distinguées. A. Chapelon (Le Chef de la Division des Etudes de Locomotives)."

This letter was a pleasant memento of the month spent in association with the S.N.C.F.

# Iron and Steel Institute

## ANNUAL GENERAL MEETING

No. II—(*Continued from page 825, June 4th*)

In the afternoon of May 26th, the reading and discussion of papers was begun. The first paper to be presented was:

### SOAKING PIT PRACTICE AT THE NORMANBY PARK STEELWORKS OF JOHN LYSAGHT, LTD.

By A. H. Norris*

This paper deals with the results of three years' experience of working a battery of one of the first post-war installations of one-way, top-fired soaking pits. The results show how modern advances in instrumentation and construction have a considerable effect on heating efficiency, in regard to both heat consumption and quality of steel. The comparatively recent tendency to use coke breeze bottoms in soaking pits is dealt with fully. The results shown in this paper should prove useful for purposes of comparison and improvement in the many other more recent installations for which results have not yet been published.

#### Discussion

Mr. S. Thomson (Colvilles, Ltd.): In the paper the relationship is shown between track time and heating time, and there is little doubt that the excellent results in fuel consumption and output are largely due to the track times. This is a point which cannot be over-emphasised in pit operation. The author quotes a figure of 10–11 therms per ton for hot material from charge to draw. Naturally, this figure does not include periods when the pit is empty or pits are ready for mill which cannot be drawn. Would it be possible to have the fuel consumption expressed in therms per ton for the complete week, from gas in on the Sunday morning to gas off on Saturday morning? That would give the true overall operating cost in terms of fuel. The figures quoted for fuel consumption, charge to draw, show a continuous record of improvement up to May, 1953. I should be glad to learn whether or not this progress has been maintained, and what is the present position with regard to fuel consumption. So far as the bottom is concerned, the brickwork is renewed yearly and the breeze bottom lasts twelve to fourteen working days with a consumption of breeze equal to approximately 0·5 per cent of the steel heated. This means, in effect, almost an addition of 10 per cent in fuel consumption. It would be interesting to have the author's opinion of the advantage of this type of bottom as against a crushed dolomite bottom. One important fact is that, generally speaking, there must always be a fairly large percentage of cold material due to the difference in working shifts in the melting shop and the mills. In view of the fact that recuperative pits are slow heaters of cold material, as the author has shown, has any consideration been given to the possibility of preheating cold material and thereby taking advantage of the undoubted efficiency of the recuperative pits on hot material?

Mr. W. Ernest (United Steel Companies, Ltd.): It may be of interest to present some operating data from a battery of two soaking pits of similar design commissioned at the works of Steel Peech and Tozer in 1953 as the beginning of a replacement programme. These pits are 22ft 6in long and 7ft 3in wide and are rated to hold sixteen 4-ton ingots. In this instance the fuel used is coke-oven gas or oil, and the use of these fuels of high calorific value has brought its own problems, especially in regard to control of flame and temperature if damage to ingots and refractories is to be avoided. Experience with these furnaces confirms the excellent results which the author has obtained. The combined coke-oven-gas and oil burner used, consisting of a series of concentrically arranged tubes

* Rolling mills manager of John Lysaght, Ltd.

made of heat-resisting steel, is introduced into the hot air main which surrounds it. The burner tip terminates approximately 2ft behind the pit end wall. Combustion begins in a circular brick port. In the original design the port diverged conically from a throat diameter of 21in. The design maximum input rating was 35,000 cubic feet per hour of coke-oven gas or its equivalent in heavy fuel oil. With this divergent port there was a tendency for ingot tops to wash and the lid showed signs of damage at a position roughly corresponding to the impact of the diverging flame. After altering the port design to a parallel tunnel 21in diameter this trouble was overcome. At the same time, the refractory in the lid was changed from firebrick to semi-silica, and this material has stood up very well to the fiercer type of flame resulting from high calorific value fuels. I can confirm the author's experience that the optimum maximum heat input to the pit is of importance. This was investigated very carefully and it was found beneficial to restrict the maximum thermal input without detriment to overall heating rates, since, although the rate of temperature rise of the pit was slightly reduced, a shorter soaking period was found adequate. The pits are now operated with a controlled maximum input of 24,000 cubic feet per hour of coke-oven gas or 75 gallons per hour of oil, and it is found that the pit is ready for drawing when the fuel input has dropped to 25 per cent of this maximum. On two further pits about to be installed the control range of the instruments is to be reduced in line with the experience gained, and better control at low flows, as mentioned by the author, is a further contributory advantage.

Mr. R. Slade (Steel Company of Wales, Ltd.): Having had some three years' experience of operating twenty modern pits at the Margam plant of the Steel Company of Wales, I read this paper with great interest. With regard to fuel operating costs, we are heating in our twenty soaking pits 33,000 tons of steel at an overall figure of about 8½ therms per ton. In a week, if the cold stock is limited to about 2500 tons when we begin the week, we may have about 1000 pit idle hours, which means that the capacity of our twenty pits is somewhere about 45,000 tons. If we had equal or better track times our fuel consumption would probably come down to something like 6 therms per ton. The author says that in his pits he makes very little slag and has only to have an ordinary firebrick for the underpinning of his linings, whereas he has sometimes to use a poker or oxygen lances to cut slag from the vents. We find the opposite. We do not have to use a poker more than three or four times a year, but for our linings, which are 94 per cent silica and last about two and a half years, the underpinning is usually in a fairly bad state after about twelve months to two years, which means that the little slag which we make seems to attack our underpinning and leave our vents fairly free, whereas at Normanby Park the reverse is the case. That brings me to the controversial problem of the wet or dry bottom. We all know that there are factors on each side. It can be said that the advantage of the wet bottom is that it saves so much time in the year or that you can reduce your manning. On the other hand, it can be said that with a dry bottom you do not damage your brickwork (which, after all, is fairly costly when you are dealing with Stein 73 bricks), so much as with a wet bottom. There are factors such as the mechanical damage to the crane in making a bottom, and also the effect on the electrical equipment of the charger crane from the dust that arises from making a dry bottom. We are experimenting on a limited basis at the moment with wet bottoms, but we have no definite data that we can offer as advice to anyone else with similar pits. At the same time, since the author claims to make very little slag, I should like to know his opinion on that matter.

Mr. W. L. James (John Lysaght, Ltd.): I have always had strong views on the fuel used. I should prefer, after many years of experience, to use as low a calorific value gas as possible, because in that way the least damage is done to the steel and there is the least risk of burning, while, in addition, it is kinder to the refractories. Reference has also been made to the question of wet bottoms versus dry bottoms. In my Steel Peech and Tozer days I knew a lot about wet bottoms and have spent many a shift, when mill superintendent there, helping the slaggers to slag the old types of pit which we had there. I can say with confidence that it is impossible to maintain the taphole of a wet pit properly.

Mr. C. H. Williams (Stein and Atkinson, Ltd.): I am sure that the author is well able to reply to all the points which have been raised, but one question which seems to be worrying a number of people with soaking pits is that of pit bottoms. When we co-operated, as we did to quite a considerable extent, with Lysaghts, we decided to put in a very ample handling scheme for coke breeze, so as to be able to put it into the pits and get it out easily. That has worked very well. Lysaghts started off with a brand new battery, and they said that they were going to be safe with their bottoms. They have never had any trouble with their bottoms other than when they were starting up the mill in its very early stages. The author will correct me if I am wrong in saying that. I think, however, that they were wearing both braces and belt. In other words, I believe that they are too careful with their bottoms and they use a little more coke breeze than is necessary. In the light of the experience which we have had at Lysaghts, when we came to build another battery of pits, which were going to be fired with blast-furnace gas, at Consett, they had had some of our pits of older types in operation for a long time and had developed a system of dealing with the smaller pits. They asked our opinion, and we both decided to take a chance, and so we put in pits which were almost similar to those which the author has described, but without any tunnel for removing coke breeze. These pits have been working for about eighteen months and have still the same bottoms in. It has not been necessary to use the crane for digging them out. They do renew the breeze, of course, and put more breeze in. What happens to it I do not know; partly it is burned away, and there is a certain amount of ash left, but you do not see any effect of it anywhere else. Perhaps it adds to the fuel consumption, but not very much, because I believe that they use 4000 lb to 5000 lb of coke breeze per pit per week.

Dr. D. F. Marshall (Park Gate Iron and Steel Company, Ltd.): There has been some discussion on whether to run with a wet or a dry bottom, but surely that depends primarily on what is to be the finishing temperature of the ingot heated in the pit and, secondly, on the time of soaking allowed for that ingot. That being so, I would ask whether the author has found any relationship between the steel quality of the billets and so on, produced from the ingot and the finishing temperature in the pit?

Mr. A. H. Norris (in reply): Mr. Thomson asked for gross figures covering the time that ingots were in the pits and the times when the pits are left empty, and so on, from Sunday morning onwards. I think that the gross figure is about 12 therms per ton. Last week it was slightly more. For this year it would be about 12½ to 13 therms per ton and for the two previous years it was probably 11½ to 12 therms per ton. To the question of whether progress is being maintained in 1953 I think I can answer "Yes." There has been no deterioration that I can see brought about by wear and tear on the pits.

On the question of dolomite versus breeze, I was responsible for operating dolomite dry bottoms in our previous rolling mills and we used to dig out the pits every ten weeks or so. I very much prefer breeze to dolomite. I had no experience of breeze bottoms before these mills came into operation, but I greatly prefer them. One reason is that we clean the pits out very frequently, every ten days, and we do not get wet bottoms on the pit at all. I think that that is of great importance to anyone who is manipulating a soaking pit. With a dolomite dry bottom which we used to dig out towards the end of the ninth or tenth week, depending on what steel had been through, we suddenly got a great ring of slag round the bottom of the ingots, which, of course, was very detrimental. We have not taken any steps to preheat cold material, for the simple reason that it has not been necessary. We have been able to absorb the outputs from the melting shop on a sixteen-shift week satisfactorily, and when we have built up a stock we can always put on a seventeenth shift. As the cycle goes, we have found that over, say, twelve months, we do not need to preheat any ingots at all, so that we have never even considered the subject.

I was interested in Mr. Slade's remarks about the slag. One of the reasons why we get so little slag is that we do not allow it to build up, even if we get it. I mentioned earlier that with the silicon steels in particular if a breakdown takes place then, even though the pit temperature is lowered right down, you still get a certain amount of slag being made. It has paid us to remove the coke breeze and ash, and the slag with it, more often and more regularly than is necessary, so that we do not make a great deal of slag. We should make more if we did not clean out so frequently. On the question of wet or dry bottoms, Mr. Slade mentioned mechanical damage to cranes through having a dry bottom. That is true to a certain extent, and we did have some damage to cranes through having to clean these pits out so frequently, but as the operators became more accustomed to this type of work and certain modifications were made to the cranes that problem diminished, and I am glad to say that it has not arisen for several weeks, if not months.

I agree with Mr. James in loathing wet slagging. I was responsible for a battery of pits for quite a number of years and was trained on wet slagging, and I detest it for the reasons which he has so ably given.

Mr. Williams takes the view that we at Lysaght's have tended to slag our pits a little too frequently. He is probably right, but we do it deliberately. Anyone who has dealt with silicon steels knows that risks must not be taken with this type of material, and if you have 1000 tons of it on a Sunday night and have a breakdown there is going to be trouble in the soaking pits, so that it is as well to be on the safe side. The cost of knocking the breeze out every ten days instead of every twelve, or every twelve instead of every fourteen, is not very great, and is more than counterbalanced by the avoidance of the trouble which might occur otherwise.

In reply to Dr. Marshall, if the steel is

at too low a temperature you gain in fuel consumption but inevitably you have trouble with cracking and so on later ; if, on the other hand, to avoid cracking and other troubles later you push the temperature up in the soaking pit, you may run into soaking pit troubles. I suppose the right answer is a sort of happy mean ; but I must come back to my first assertion, that the main factor is not temperature but soaking.

The following paper was then presented by Mr. F. T. Bagnall† and Mr. W. C. Heselwood.‡

## SOME FACTORS AFFECTING THE WEAR OF GRAPHITE ELECTRODES IN THE ELECTRIC-ARC FURNACE


### Synopsis

A co-operative investigation by members of the Electric Process Sub-Committee and the research staffs at their plants has shown that abnormally rapid wear of graphite-electrode collars is usually associated with a high electrical resistivity, which is probably due to incomplete graphitisation of the material. The heating of joints is likely to be aggravated by certain features of nipple and socket construction when the resistivity is high. Simple non-destructive resistivity tests for complete electrodes have been devised and are described. These tests indicate that in the case of a " bad " electrode the resistivities of the ends are often higher than that of the middle.


### Discussion

Dr. A. H. Leckie (Iron and Steel Board) : Most readers of the paper will make the comment that the sub-committee lists at the beginning the five factors which concern wear and then spends the rest of the paper discussing only one of them. Mr. Bagnall has said that most of the members of the sub-committee are practical steelmakers and are well aware of the importance of all the other four points listed, and that the quality of the electrodes is the one item over which the practical steelmaker has least control ; but I hope that when the sub-committee is next in a position to report on electrodes some of the other factors will be discussed a little more, because, although I appreciate that the practical steelmaker is well aware of the importance of all these other factors, he is not the only person concerned with electrodes, and the other factors are important as well. For instance, I should like to ask whether the sub-committee can say definitely whether or not a decrease in the time of the heat which one would expect following an increase in transformer capacity does result in a decrease of electrode consumption per ton. That brings in an important cost question. Again, common sense suggests that one of the biggest factors governing electrode wear is the surface area of electrode exposed at high temperature. Can the sub-committee yet specify the minimum diameter of electrode applicable to any given size of furnace, bearing in mind the data published in the 1949 report, which suggested that most electrodes in this country were run at a current density considerably less than that specified by the makers ? If you use a smaller diameter electrode you increase the risk of breakage. I believe that at one time B.I.S.R.A. even considered the use of water-cooled electrodes, but was put off by the calculated heat losses in the cooling water. Is it too far-fetched to suggest a water-cooled metal core for a graphite electrode, which would strengthen the stick, to permit smaller diameter ? There is a good deal of evidence that electrode consumption is strongly correlated with the diameter.

Coming to the main subject of the paper, the influence of resistivity on wear, I am not surprised to see that an acceptance test is recommended. After all, most steelmaking raw materials are tested before use. Refractories are generally subject to inspection for quality, and there is no reason why a consumable material such as graphite should not be treated in the same way. I have no doubt that the manufacturers will welcome the suggestion made by the sub-committee that electrodes should be tested, because if you make a good article an acceptance test provides material for very good advertising.

The suggestion of the sub-committee as to why electrodes wear more rapidly at the joint is very ingenious. The sub-committee suggests that the conditions might be improved by the use of tapered nipples. Are trials being done with these nipples in this country ? The paper concerns itself entirely with graphite electrodes, and I suppose that the economies which might be attained by improving graphite consumption to a substantial degree may amount to several shillings per ton. It has been suggested on several occasions in the past, however, that even bigger savings could be obtained by using paste electrodes of the Söderberg type. The sub-committee was interested in this at one time, and I suggest that trials should be carried out to confirm whether or not worth-while savings can be made in this country.

Mr. D. H. Houseman (K. and L. Steelfounders and Engineers, Ltd.) : Two factors arise in using higher resistivity electrodes. The first, that of increased wear in the arc, is serious enough from a direct cost viewpoint, while the second, that of electrode breakage in the furnace, results both in wasted electrode ends and in loss of melting time since, as Brandt and Glaisher have pointed out, breakages due to " necking " of the high resistivity portions of electrodes usually occur in the early part of the melting cycle, due to mechanical stresses set up when the electrodes bore into the scrap ; melting conditions are here at their severest while removal of the broken electrode end is troublesome at this stage. Doubtless the " heating " effect due to the higher resistivity of " bad " graphite electrodes near joins is further enhanced by the steady fall in thermal conductivity that occurs with increasing temperature. Thus, for reasons both of cost and of convenience, the use of high resistivity electrodes in the electric arc furnace is undesirable and we are co-operating with our electrode suppliers in an endeavour to minimise this use.

Mr. T. H. Mowbray (British Acheson Electrodes, Ltd.) : In so far as the investigation pinpoints attention on electrodes we are glad of it. To get the lowest possible electrode consumption per ton of steel is something which is in front of us the whole time. We have tried to educate people to the need of using as few pounds of electrodes per ton of steel poured as possible. We do not want to do anything to smother investigation or discussion of the subject. Reference has been made to the question of an acceptance test. I must point out that an acceptance test is difficult to operate. It is a practical impossibility to regraphitise a machined electrode. I would ask you to keep in mind that we check the electrode for resistance before it is machined, so that if we find more than a certain minimum that are on the top side for resistance we can regraphitise them ; but, having passed the check for resistance after graphitisation, they are machined, and once an electrode has been machined it is difficult to do anything to improve it. We have changed our method of checking resistance in the plant but it is still not a practical proposition to check every piece. Mention has been made of the tapered nipple. I believe that there are at least two tests running now, with a third in prospect. I do not want to prejudice you by any observations which I make, but two fairly large users in America and on the Continent have tried them and discarded them.

Mr. George Wood (English Steel Corporation, Ltd.) : I am inclined to think that Mr. Bagnall has over-emphasised the resistivity and not laid enough emphasis on the surface area. I think that the surface area has more to do with the loss of electrodes which we experience than the resistivity alone, but the two taken together certainly account for quite a lot of it. Against that there is the question of trying the Swedish paste electrode, but no one has mentioned trying the amorphous carbon electrode which is available in this country. With a number of our furnaces we are using the amorphous carbon electrode and get a much lower cost than with graphite.

Mr. F. T. Bagnall : The easiest and most convenient electrode to use is the graphite, and personally I prefer to economise to the limit on the graphite rather than have to use amorphous. With regard to the Söderberg electrode, the question of size comes into it. On the 60-ton furnace which we are putting in this year we are to use 20in graphite. We should need three 36in holes in the arc furnace roof if we used amorphous or Söderberg, and I do not think that amorphous carbon electrodes are made to that size.

Mr. F. Crankshaw (K. and L. Steelfounders and Engineers, Ltd.) : On the question of the use of amorphous electrodes, with the present trend of raising the transformer capacity of small furnaces it would be difficult. It would be very difficult, as Mr. Bagnall suggested, on a 60-ton furnace, but it would be equally difficult with a furnace with a shell 8ft 6in in diameter where you are putting 8500kVA into it. We already use 10in electrodes, and if they are spread out the arcs would be too near the side walls.

Mr. J. C. Howard (Electric Furnace Company, Ltd.) : The question of cost is of major importance, and I do not think there is any doubt that the Söderberg electrode is considerably cheaper than the graphite or the amorphous carbon electrode. When we are competing in world markets and trying to produce steel better and more economically than our competitors we have to meet the competition of steel makers abroad who make this steel, and the very fact that a number of Continental makers use Söderberg electrodes makes their use something which we should not dismiss too lightly. I agree with Dr. Leckie that development work should be carried on on the Söderberg electrode.

The surface area of the electrode must have a very big influence on electrode consumption. Undoubtedly the greater the surface area the greater will be the electrode consumption. That makes us think first of all of trying to use a smaller diameter electrode, and obviously the result will be an improvement if we do not go to too small a diameter. But the length of the electrode also has its influence. On any particular furnace we cannot alter the length of the electrode within the furnace, because it is dependent on the furnace design itself, and the furnace design has to be a sort of compromise from an electrode consumption point of view.

*(To be continued)*

† Samuel Fox and Co., Ltd.
‡ United Steel Companies, Ltd.

# Symposium on Mix Design and Quality Control of Concrete

WE have received from the Cement and Concrete Association a technical summary of the recent symposium on mix design and quality control of concrete, which took place at the Empire Rooms, Tottenham Court Road, on May 11th–13th. Some remarks from the summary are printed below.

It would appear from the papers that the authors were in agreement over most of the technical ideas presented, but nevertheless there were lively discussions on a few points of difference. If any fashion was started at this symposium, it was to talk about the use of statistics in quality control methods. Yet it was obvious from remarks made by a number of speakers that for the most part the material presented to the symposium was not new; much of it had been known for twenty years or more.

It seems that the method of designing concrete mixes outlined in Road Note No. 4 has become generally accepted in this country; it fulfils the essential requirement that the mix proportions are selected to make the best use of the available supplies of aggregate. The method is based on Abrams's water/cement ratio "law" that the compressive strength of concrete at any age depends primarily on the water/cement ratio of the mix. Although it was shown that the richness of the mix and the type and grading of the aggregate also affected the compressive strength, these factors need not normally be considered unless the concrete is to have a comparatively high compressive strength. A number of speakers emphasised that any method of mix design should be checked by making full-scale trial mixes, and calculations could sometimes be replaced by experience.

It has been possible, with the development of mix design and control methods, to achieve specified minimum compressive strength with leaner mixes. However, repeated reference was made to the dangers of accepting the cube test as the only criterion of quality, and to the importance of the durability and impermeability of the concrete. It was suggested that these properties might be overlooked in the desire for leaner mixes and that they could only be safeguarded by having a concrete with a minimum cement content. On the other hand, it was pointed out that the richer mixes used in structures erected several years ago did not save many of them from serious deterioration.

It was suggested that the workability and compressive strength of concrete were not affected by the grading of the aggregates provided the specific surface of the aggregate particles was the same. It would appear, therefore, that concrete of similar properties could be made with either gap or continuously graded aggregates, and that it should be possible to combine any aggregates complying with B.S. 882 to make good concrete. However, it was suggested that concrete made with gap-graded aggregates was more liable to segregate, and it should only be used where the workability is suitable for compaction by vibration and where a high degree of quality control is to be exercised.

The statistical approach to the cube test leads to the idea that a small stated percentage of results should be expected to fall below the specified minimum value; this interpretation of "minimum" value was challenged and the view was expressed that any concrete represented by a cube result which did not come up to the specification requirement should be cut out. Other speakers pointed out that this approach was impracticable under many conditions and even undesirable where the cube making and testing technique was suspect; the problem should be faced when specifications are drafted and not left to a site meeting when the first cube fails to reach the required minimum. In any case, each example of a result which failed to come up to the required standard should be treated individually and the reasons for the failure thoroughly investigated. Reference was made to the use of non-destructive testing, by measuring the velocity of an ultrasonic pulse through the concrete, as a check on the quality of the concrete in the structure.

It was evident that there is as yet insufficient data available to decide whether the variation in cube results obtained under site conditions with any particular degree of control can be assessed more accurately by the standard deviation or the coefficient of variation. It seems that the coefficient of variation would be more applicable to laboratory tests where the variation in results is mainly that inherent in testing technique, but such evidence as was available to some speakers suggested that the standard deviation was the more appropriate to the variation of test cubes made under site conditions. It may well be that neither is constant for a particular degree of control, but that the coefficient of variation tends to become the more accurate as the degree of quality control improves.

There seemed little doubt that where control methods were applied according to the requirements of the job, there was a definite saving in the overall cost of the work, but it was not always clear when it would be profitable to apply particular techniques. A high standard of quality could be obtained on the small jobs by introducing ready-mixed concrete or by using precast concrete products. Many speakers referred to the high degree of control which could be achieved if the amount of water added at the mixer was based on a trained mixer driver's assessment of the workability of the concrete.

It was announced that the City and Guilds Institute had recently decided to introduce a certificate in concrete practice, which should help considerably in the training of clerks of works, general foremen and mixer drivers; the success of the scheme would depend on a sufficient number of suitable people offering their services as lecturers. While there was no doubt that the supervisory staff should be thoroughly trained, there was some difference of opinion as to the need and desirability of extending training schemes to the man actually carrying out the work.

The discussions showed where further research or attention should be directed. Devices were needed to measure the workability of concrete while it was still in the mixer, to measure the water/cement ratio of fresh concrete and to measure the degree of compaction of concrete after placing in the moulds. There was a renewed demand for an accelerated cube test, by which the seven-day or twenty-eight-day cube strength could be forecast from results obtained in a day or less. Research was needed to study other properties of concrete than compressive strength, particularly durability and impermeability, and to establish what was referred to as the "effective" water/cement ratio of a mix. A planned investigation was required to provide data about site cube results from which the statistical properties of their distribution could be assessed more precisely.

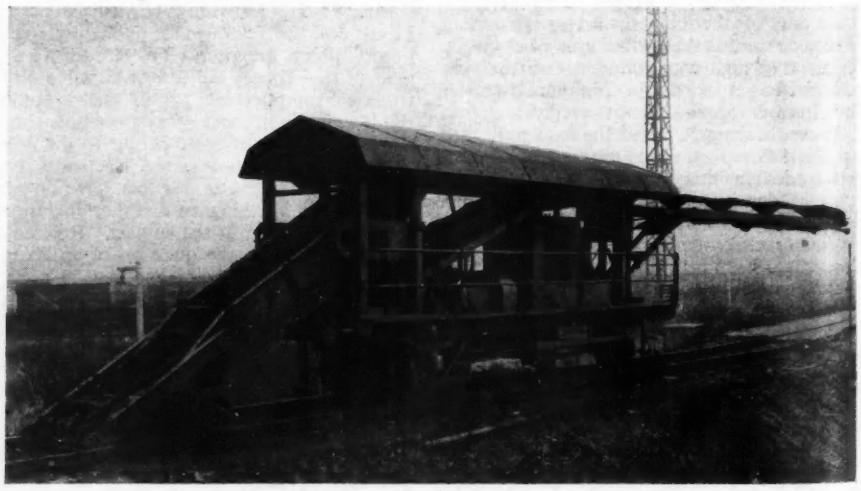
## Siding Clearing Machine

A NEW machine for clearing debris from the track in railway sidings and yards has been designed and built by Rownson Drew and Clydesdale, Ltd., of London, in conjunction with British Railways, Derby. This machine, shown at work in the illustration on this page, is capable of clearing 3 tons of debris per man-hour from between the tracks—equivalent to four times the amount previously loaded by hand.

The machine is built on a long wheel base wagon with a suitably stiffened frame and is driven by a McLaren oil engine developing 44 b.h.p. at 1000 r.p.m. It consists essentially of a scraper chain mounted on a boom and the debris picked up by the chain as the machine is driven forwards is deposited on to a belt conveyor take-off boom at the rear of the machine. This take-off boom can be swivelled to deliver the debris into empty wagons at the rear of the machine or at its side.

Drive from the engine is transmitted via a clutch to a three-speed gearbox with a separate reverse for travel. For propelling the machine along the track drive is transmitted to one axle through a chain and final spur reduction gearing. This drive can be disengaged when the machine is required to travel in train formation at speeds up to 45 m.p.h. The normal digging speed is 20ft per minute if the debris is consolidated, but the second speed of 50ft per minute can be used with loose material. The "top" gear provides a travelling speed of 75ft per minute, which enables the machine to work without locomotive power for positioning in a siding. Both the scraper chain boom and the take-off boom can be raised for storage on a "runner" vehicle when the machine is travelling between working sites.

To operate the machine the normal gang comprises ten men including the driver, who stands on the machine to operate the digger scraper chain drive clutch and the travel clutch to the instructions of two men at the digger, who are responsible for clearing metallic objects from the debris to avoid jamming the chain. In case of a jam a preset slipping clutch safeguards the chain and transmission. The other men are employed at the front and rear of the machine to trim the debris.



**Siding clearing machine in operation with scraper boom lowered and take-off conveyor boom depositing debris on one side**

# Mechanical Handling Exhibition

No. I

ON Wednesday last the fourth Mechanical Handling Exhibition was opened at Olympia, London, by Mr. A. R. W. Low, Parliamentary Secretary to the Ministry of Supply. At this exhibition, which will be open daily until Saturday, June 19th, a very comprehensive range of the mechanical handling and ancillary equipment made by nearly 200 firms in this country is being displayed. At a convention of mechanical handling held in conjunction with the exhibition, many papers on various aspects of the subject are being presented by specialists. In the following descriptions we deal with some of the new equipment on show.

The large number of mobile cranes exhibited include a new lorry-mounted crane by Steels Engineering Products, Ltd., Sunderland, which, with its capacity of over 41 tons, is stated to be the largest machine of its kind yet built. This crane, known as the "Colussus" is illustrated in Fig. 1. It is fitted with a 30ft tubular jib and lifts up to 92,000 lb at 12ft radius. The eight-wheeled chassis on which the crane is mounted has a four-wheel drive and is powered with a Rover "Meteorite" 250 h.p., eight-cylinder, oil engine. Power is transmitted from the engine through a tandem drive with double reduction on each driven axle, the primary reduction being by worm gearing and the secondary reduction by two epicyclic trains. Twelve forward and three reverse speeds are provided, and all wheels are fitted with compressed air brakes. Power-assisted steering gives complete control of the vehicle under all conditions, and the chassis is fitted with telescopic girder stabilisers and screw jacks, which can be extended when the crane is in operation.

The superstructure slews a full circle and can be fitted with a 90ft strut jib of tubular lattice design and, if required, with an additional fly jib to increase its maximum height to over 100ft. The power unit for the crane motions is mounted in the superstructure and comprises an 80 h.p. Perkins "D.6" oil engine driving a variable voltage generator. Separate motors supplied with current from this generator actuate the hoisting, derricking and slewing motions. These motors are each fitted with electro-mechanical brakes which are immediately applied in the event of the current supply being cut off. The variable voltage system used on the crane provides simple control of all the motions, more than one of which can be operated simultaneously, as in other cranes made by the firm. The unladen weight of the crane is about 50 tons and its wheel base is 21ft long.

This firm is also showing three other self-propelled mobile cranes, with capacities of 3, 5

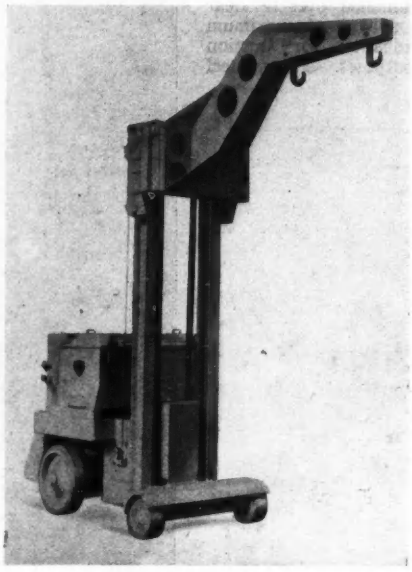


Fig. 2—"Electric Eel" battery-operated crane truck with a lifting capacity of 25 cwt

and 10 tons at 10ft radii, and the "Electric Eel" crane truck illustrated in Fig. 2. This battery-operated truck has twin masts on which a carriage supports a horizontal jib designed to lift 25 cwt. Its fabricated steel chassis frame carries a large 40V lead acid battery and the control gear. Two travel motors are mounted on the driving axle. The controls comprise wheel steering, through a cam-and-follower steering box, a hand lever for travel control and two braking systems: one is foot operated and the other is electric resistance braking, operated from the controller hand lever.

The jib carriage is elevated by an electric motor which, through a reduction gearbox, drives two triplex roller chains. Automatic limit switches prevent overriding of the jib carriage and the jib is lowered under the control of a centrifugal brake.

Among the many makes and sizes of fork lift trucks exhibited there is the recently introduced model "60 DH" heavy-duty "Stacatruc," made by I.T.D., Ltd., 95–99, Ladbroke Grove, London, W.11, illustrated in Fig. 3. This machine has a maximum capacity of 7000 lb at a 14in load centre and is made with lift heights of 6ft, 9ft, 12ft and 14ft, the 12ft lift model being that exhibited.

The truck is driven by a Perkins "P–4" oil engine rated at 40 b.h.p. at a governed maximum speed of 2200 r.p.m. The drive is taken through a single-plate clutch to a gearbox giving two forward and two reverse speeds, the maximum designed speed being 10 m.p.h. From the gearbox, drive is transmitted to front axle half-shafts by bevel gearing through a heavy-duty differential. A particular detail in the design of the chassis of the machine is the means provided for drawing the front and rear sections apart to give quick and easy access to the main units. The rear section of the chassis carries the steering axle and road spring assembly, and the front section carries the driving axle assembly and hingebar for the mast assembly. The front section of the chassis is mounted to slide on channel guides

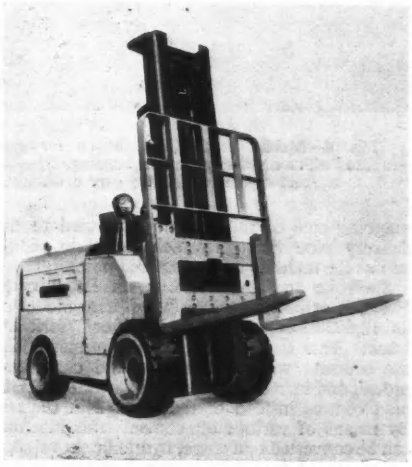


Fig. 3—7000 lb capacity "Stacatruc" fork lift truck with 14ft lift height, and having "split chassis" construction to facilitate access to main units for maintenance and servicing

on the rear section in such a way that, by removing the clamping bolts and those on the steering drag link and clutch housing, the two sections can be slid apart to give free access to the clutch, gearbox and transmission assemblies.

The mast channel framing of the machine consists of one inner and one outer assembly, the outer being pivoted on a hinge bar on the front chassis frame for the tilting operation. It is operated through the tilting range by brackets engaging the hydraulic tilt rams. The inner channel is a sliding fit in the outer channel and on it the fork carriage moves vertically on rollers. The carriage is supported by two laminated chains which pass over rollers mounted on ball bearings fitted to a crosshead attached to the lifting ram. Pressure fluid for the hydraulic system is provided by a Plessey pump capable of sustaining a pressure of 2400 lb per square inch, and the hydraulic equipment is designed to give a maximum lifting speed of 36ft per minute and tilt the full working load 3 deg. forward and 10 deg. backwards.

The conveying and elevating equipment shown by Conveyors (Ready Built), Ltd., Cainscross Works, Stroud, Glos, includes a pneumatic mobile conveyor for grain and similar materials which the company is now making under licence from the United States. This piece of equipment,

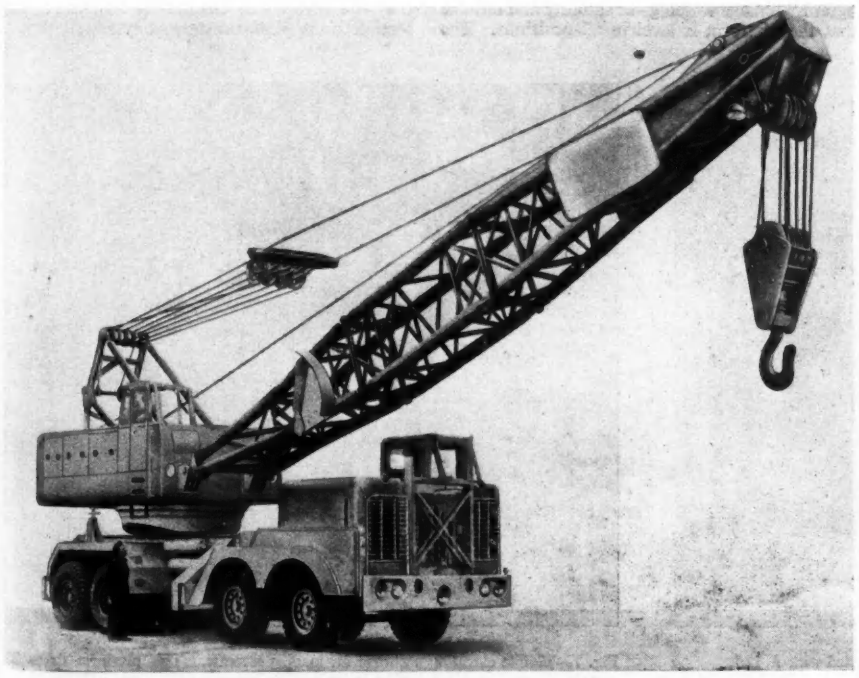


Fig. 1—Lorry-mounted mobile crane with 30ft jib for lifting up to 41 tons at 12ft radius.

known as the "Grainvayor," is illustrated in Fig. 4, and it is designed to pick up and deliver granular materials to distances up to 250ft away from ships, silos, trucks, &c.

The plant is mounted on a rigid steel chassis carried by four pneumatic wheels and is driven by a Lister 54 h.p. oil engine. The intake nozzle at the end of a light flexible suction pipe can be adjusted in accordance with the volume and type of granular substance being handled. Material is drawn through the suction pipe by a multi-stage turbine impeller, which it by-passes through a cyclone on the suction side. From the suction side of the cyclone the material is transferred to the pressure side of the pneumatic system through a rotary discharge lock which provides an effective air and vacuum seal. The outgoing side of this lock is connected to the delivery pipe through which the flow of air carries the material to the required point.

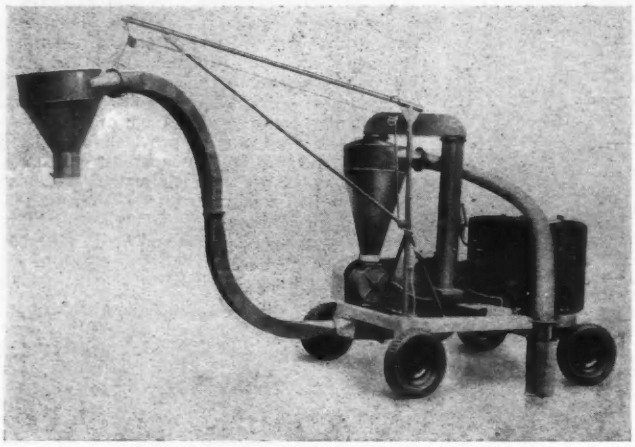


Fig. 4—Mobile pneumatic conveyor for granular materials. It is fitted with a multi-stage turbine impeller, driven by a 54 h.p. oil engine, and capable of delivery over a distance of 250ft

Shelvoke and Drewry, Ltd., of Letchworth, Herts, is exhibiting a long wheel-base model of its 18,000 lb capacity "Freightlifter" fork lift truck. This machine is intended primarily for use overseas where adverse ground conditions prevail and its maximum capacity is rated at 33in load centres instead of the usual 24in centres. By means of various attachments this machine can be converted to a crane, hydraulic shovel, &c.

The trucks and tractors on the stand of the Mercury Truck and Tractor Company, Ltd., of Gloucester, include the recently introduced "10 F" machine illustrated in Fig. 6. This small tractor is designed for haulage work in factories, yards, airfields, &c., and has a towing capacity of 10 tons. It is fitted with a four-cylinder engine developing 25 b.h.p. at 2800 r.p.m., and has three forward and one reverse speeds. The tractor has a channel steel frame and an iron casting weighing some 800 lb is mounted over the rear axle to give the maximum adhesion for traction purposes. Heavy steel bumper plates are mounted rigidly on the front and rear of the chassis and the cast iron towing jaw coupling takes a 1in pin.

An interesting prototype shown by this firm is a truck fitted with a power-operated hydraulic elevating platform for use in loading freight into aircraft. This platform can be elevated to any height between 3ft 4in and 11ft 6in above ground level. It is 9ft 6in long by 5ft 6in wide and takes a load of up to 25 cwt.

The aluminium chequer-plate platform is supported from the vehicle chassis by a "parallelogram" linkage which gives stability and ensures that the platform is level in all positions. The main link members are of welded plate construction and are connected by tubular cross members as can be seen in Fig. 7.

To maintain stability bell cranks attached to the rear main members of the lower section are connected through pivoted links to the front main members of the upper section of the platform support system. This arrangement ensures that each section of the system operates simultaneously and prevents the linkage from collapsing.

The platform is raised and lowered by operation of two triple-extension, hydraulic rams supplied with oil by a pump driven from the power take-off of the vehicle engine. At their lower ends these rams are supported in a cradle slung below the chassis and at their upper ends they are pivoted to channel beams in the top section of the platform support system.

Fig. 5—7½-ton mobile "K.L." crane, with a lattice 25ft jib. This jib can be increased to 65ft and fitted with a 9ft jury mast jib

Fig. 6—10-ton capacity Mercury towing tractor fitted with a 125 b.h.p. petrol engine

Fig. 7—Mobile elevating platform for loading aircraft. This platform takes 25 cwt of freight, and its height is adjustable between 3ft 1in and 11ft 6in above ground level

A new mobile crane of 7½ tons capacity shown by George Cohen, Sons and Co., Ltd., Wood Lane, London, W.12, is particularly intended for work on construction sites and can be fitted with a four-piece sectional lattice jib to give a total length of 65ft. This crane, to be seen in Fig. 5, is of the same general design as the other cranes in the "KL" range. It is driven by a Perkins oil engine developing 37½ h.p. at 1500 r.p.m., which provides power for travelling, hoisting, slewing and derricking. For travelling a four-wheel differential drive is provided and the steering is power assisted and automatically corrected.

Each of the crane motions is operated through single, self-centring levers and the travelling motion is engaged through a lever mounted on the steering column. A sprag lever locks the superstructure in any position and prevents the slew control from being operated until the superstructure is freed. Brakes are fitted to all the motions, those for the winch and derrick being automatic in action.

The standard lattice-construction jib consists of four sections which can be assembled to provide working lengths of 25ft, 45ft and 65ft. This jib can be fitted with a 9ft 6in jury mast jib extension, designed to give the advantages of a swan-neck jib without sacrificing the crane's capacity for straight jib working. Alternative jibs can be fitted for specific duties, one being a 40ft swan-neck jib which permits a 2-ton lift at 32ft radius, and is specifically designed for handling prefabricated house sections.

A stand-on, straddle, fork reach truck now being made by Lansing Bagnall, Ltd., Basingstoke, Hampshire, is illustrated in Fig. 8. With this machine, the mast assembly is moved forwards so that the forks project beyond the front wheels to pick up or deposit loads. Whilst travelling with a load the mast of the machine is retracted within the frame. It has a capacity of 1 ton at 20in load centre and a lift of 10ft.

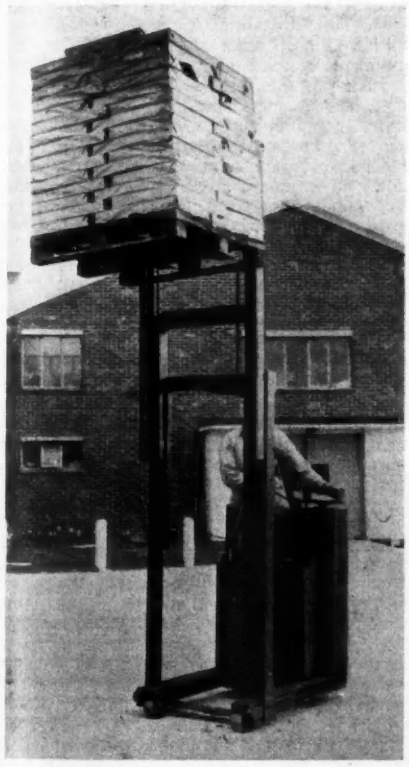


**Fig. 8—Stand-on, straddle, fork-reach, 1-ton capacity truck. In this vehicle the mast assembly can be moved forwards to deposit or pick up loads, and retracted during travelling**

As can be seen from the illustration, which shows the mast assembly extended, the forward wheels form the fulcrum about which the moment of the load acts. This load is balanced by the weight of the power unit and battery at the opposite end of the base frame members. The mast vertical members are of inverted "T" shape and their horizontal parts run on rollers in the channel section frame members. The mast assembly is extended and retracted by sprockets and chains by a hydraulic ram controlled separately from the hoisting and lowering control of the fork carriage. An interlock prevents the electric motor from being engaged for travelling, while the reach mechanism is in operation.

The load hoisting chain system has been redesigned to give the operator completely free visibility through the mast and the jack is set close to the left upright. The chains, supported by sprockets, run in the channel section mast. The flexible pressure hose feeding the hydraulic fluid to the jack is supported and protected by a jointed guard which "jack-knifes" as the mast is retracted.

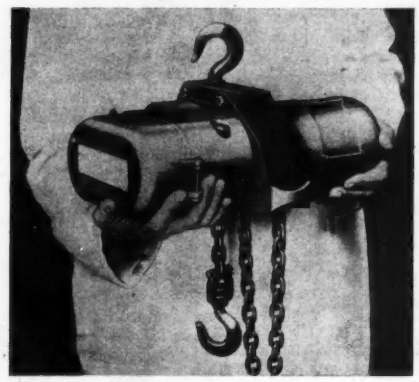


**Fig. 9—Electric pulley block weighing 35 lb and made in two capacities of 100 lb and 200 lb**

The truck chassis consists of two separate halves connected by a horizontal pivot and the mating surfaces of the rider chassis and the load chassis are lined with friction pads. The front and rear halves of the truck therefore have a limited amount of movement relative to each other about their common horizontal axis. This articulation has enabled the truck to be provided with four wheels, and gives a high degree of stability whilst ensuring constant contact of all wheels with the ground.

The driving wheel and motor form an integral unit which can be steered through an arc of over 180 deg., so that the truck can turn in its own length. Steering is by means of a hand wheel and the forward and reverse control and the speed control are combined in a single handle. A dead man's pedal is provided on the stand-on platform, so that the truck cannot be driven unless the operator is in position; the control handle is spring loaded into the neutral position.

Power is provided by a 500Ah, 12V battery housed in a detachable battery case provided with lugs for ease of removal where twenty-four-hour truck operation makes necessary the use of a spare battery. Normally, the battery is recharged in position by plugging the built-in charger into a suitable mains supply.

The maximum speed of the truck is 5 m.p.h. and its service weight, including battery, is 3250 lb.

A small electric-motor-driven pulley block now being made by Geo. W. King, Ltd., Stevenage, Herts, is illustrated in Fig. 9. This block is available in two capacities, 100 lb and 200 lb, with respective lifting speeds of 100ft per minute and 200ft per minute. In the form illustrated, where it is fitted with a hook, the block weighs only 35 lb, and when it is fitted with a push trolley it weighs 40 lb. The block is driven by a ¼ h.p. motor arranged in the steel frame on one side of the chain wheel and driving through a gearbox on the other side of the wheel. It has an automatic screw load brake with double pawls and a limiting device comes into effect at the top and bottom positions of the hook. Hook raising and lowering is controlled by a pendulum push-button box which can be arranged at a convenient operating level.

**Fig. 10—Assembling 10ft long sections of conveyor track, showing joint and hanger in position**

An overhead chain conveying system erected on the stand shows a representative arrangement of the firm's "P.C.P." easily erected light conveyor equipment. The track for this design of conveyor is built up from 10ft lengths of "L" shaped pressed steel sections, which can be supplied in straight lengths or ready-bent for vertically curved track up to 90 deg. or horizontally curved track of any angle. As shown in Fig. 10, the sections have holes drilled at 2in centres for assembly in pairs with spacer bolts to form a track of the required length and contour. The track sections are connected by fish-plates with slotted holes and the sections are staggered to impart the maximum strength to an assembly.

Hanger brackets of special design are used for supporting the conveyor track and the wheeled trollies supplied to carry the loads have a rated capacity of 100 lb. The link chains used for connecting the trollies can be supplied with motor-driven sprocket drive units to suit various applications.

R. A. Lister and Co., Ltd., of Dursley, is exhibiting its power loaders and three auto-trucks, one of which will be fitted with a fork lift. The arrangement of this fork lift truck is shown in the accompanying drawing (Fig. 11),

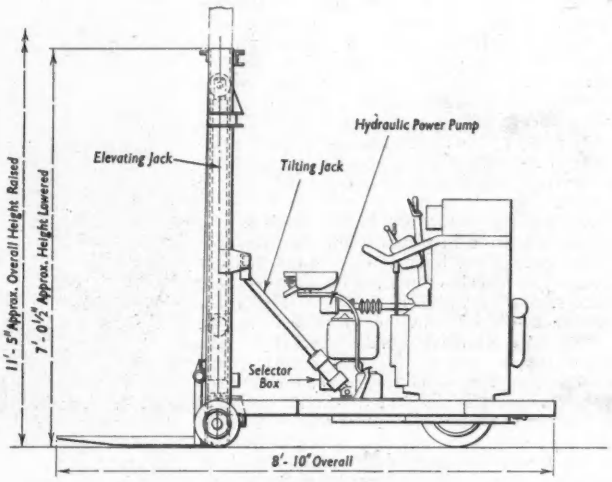



**Fig. 11—Auto-truck fitted with a 1000 lb hydraulic fork lift**

and it is designed to raise loads of up to 1000 lb to a height of 9ft.

The channel section elevating mast for the fork lift is mounted over the rear axle of the truck and it can be tilted forward 3 deg. or backwards 5 deg. Hydraulic pressure fluid for operating the fork lift is provided by a pump driven from the engine and, through a selector box, is directed to the fork elevating ram or the tilting ram. The forks are 2ft 6in long and are adjustable for width between 10in and 2ft 6in.

Another of this firm's trucks is shown fitted with a four-section timber tower ladder, which can be elevated to a maximum platform height of 24ft 6in. Ladder raising on this truck is effected by a hydraulic ram supplied by an engine-driven pump.

An exhibit of interest amongst the products on the stand of Flexello Castors and Wheels, Ltd., Bath Road, Slough, Bucks, is the firm's new "floating hub wheel," illustrated in Fig. 12.

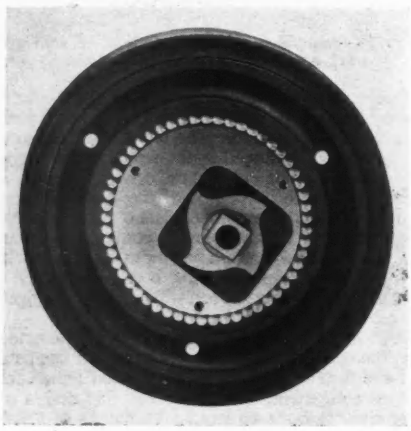


**Fig. 12—Combined swinging, and shock-absorbing, floating hub castor wheel**

This wheel was developed in collaboration with the Andre Rubber Company, Ltd., and is based on what is known as the Andre/Neidhart system. Its design is such that the wheel proper can change its position in relation to a fixed "axle" on which it is suspended through rubber inserts, which provide springing and shock-absorbing properties.

As can be seen, the wheel assembly has a formed inner support member or axle which is secured on the castor legs by means of its squared ends so that it cannot turn. This axle through four rubber inserts supports the hub proper on which an annular wheel member revolves on roller bearings. The axle body is located on a square offset orifice in the hub and the rubber inserts are held in compression in the corners of the orifice by the profiled sides of the axle.

The illustration shows the relative positions of the wheel members in the normal loaded condition and where the tendency for the hub to turn on the offset axle is resisted by the rubber inserts. When the loaded wheel passes over a small projection on a floor it is forced upwards and a springing effect is imparted as the hub turns on the axle an amount controlled by the hardness of the rubber inserts which are further compressed. Shock loads are absorbed in a similar way by the inserts and the turning movement of the hub, which is afterwards restored to its normal position by the expansion of the inserts.

A non-clog castor has been introduced by this firm for use in places where threads, fibre string, &c., on the floor necessitate the frequent cleaning of wheels of normal design. In these castors, one of which is shown in Fig. 13, a mushroom-shaped wheel is mounted at an angle on a cranked spindle carried by the swivel support mounting. The load is transmitted from the wheel to the spindle through a hardened steel ball and a second steel ball is inserted between the head of the spindle and the support. The spindle and the wheel can rotate freely even when they have picked up string or threads, and the design is such that, when necessary, the threads can be burnt off quickly with a blow lamp without damage to the castor parts. The makers state that castors of this design have a very long life and do not require lubrication whilst in service.

A lorry-mounted crane built by Thomas Smith and Sons (Rodley), Ltd., Rodley, near Leeds, is designed for general crane duties, as

**Fig. 13—Non-clog castor for use in textile factories, laundries, &c.**

well as for excavating, grabbing, &c. It is fitted with a fully revolving superstructure which carries its own power unit and is capable of lifting a maximum load of 15 tons at 10ft radius when rigged with 30ft boom. By the addition of extra sections the all-welded tubular boom can be extended in intermediate 10ft lengths up to a maximum of 100ft.

A high "A" frame allows long jibs to be raised without assistance and this frame can be folded down for travelling on the highway. An additional jib tip 15ft long which can be fitted to a boom head up to 80ft provides an auxiliary hoist and means of additional lifting clearance.

The lorry frame of reinforced steel construction embodies the crane turret and draw beam housings. The draw beams are fitted with adjustable jacks and can be extended to 13ft centres, to provide adequate stability for heavy loads or high-lift work.

A selection of its relay and lever-controlled variable-speed drives suitable for application to mechanical handling plant is to be seen upon the stand of Carter Gears, Ltd., Thornbury Road, Bradford. The positive displacement hydraulic variable-speed gears made by this firm are available in sizes from $\frac{3}{4}$ h.p. to 22 h.p.

The "Junior" gear, which is made in two sizes rated at $\frac{3}{4}$ h.p. and $1\frac{1}{4}$ h.p., is illustrated

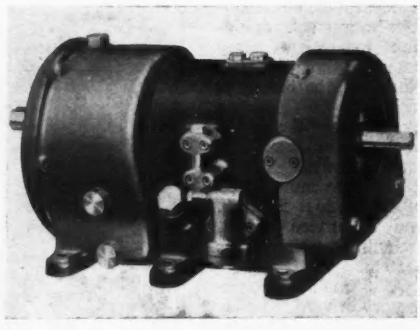


**Fig. 14—Hydraulic infinitely-variable-speed gear with flange-mounted spur reduction gear**

in Fig. 14, and at these maximum output ratings the output speeds of 1420 and 1430 r.p.m. respectively are infinitely variable in forward and reverse direction of rotation. The input shaft is driven in one direction only, and the output shaft speed is adjustable from full input speed clockwise through zero to full input speed anticlockwise without reversing the input drive. Full output torque is available at all speeds.

The gear illustrated has a hydraulic relay control, oil from the gear being used to operate a piston relay with compensating valve gear. With this form of control the whole speed range is made available with the exertion of a very small effort on the control lever. It is also fitted with a flange-mounted spur reduction unit for low-speed, high-torque conditions.

An electric remote control system which can be supplied for these gears enables the speed to be set accurately from any number of distant points. With this form of control speed changes can be effected whilst the machine is in motion, or the required starting speed can be set whilst the drive is at a standstill.

*(To be continued)*

## Vaal River Bridge, Vereeniging

As part of the railway improvements programme in the Vereeniging area the main line to the Orange Free State is being deviated and doubled and will cross the Vaal River on a new bridge situated about a mile downstream from the existing one. For various reasons, each track will be carried on a separate bridge, the two bridges being placed side by side on abutments and piers common to both. The bridge has three main steel spans of the trussed deck type, each measuring 150ft between centres of bearings, 17ft maximum overall depth and weighing 259 tons. They will be flanked at either end by three 30ft semi-circular concrete arches.

The piers for the main spans are of concrete, brought up some 46ft above the river bed where the foundations are taken down about 5ft into a deep seam of coal. The piers and abutments of the flanking arches are carried on concrete pile foundations. Due to the presence of a barrage some miles downstream there is normally a 20ft depth of water at the bridge site. The height from normal river level to the underside of the steelwork is, therefore, about 26ft. The spans were designed so that they could be erected on one bank of the river, rigidly connected together end to end, then "end launched" in one piece right across to the other bank without the need for falsework. This erection procedure was one of the factors which dictated the use of a separate bridge for each track.

For launching the Vaal River bridge, rollers carried in the frames fixed on the Transvaal abutment were connected through trains of gear wheels to manually operated cranks; the rollers were held in a fixed position on the abutment and so the structure itself was forced to move forwards on operation of the cranks. Thus, the three spans connected end to end were launched across the river, being picked up in turn by pier rollers and finally by those on the Orange River abutment. The use of the geared rollers provided the desired control throughout the complete operation. Speed of launching could be varied and the large structure brought to rest in any required position to within a fraction of an inch. All components of the spans were not in place when the structure was launched but the weight of the steelwork moved was over 500 tons, and the overall length approximately 500ft. The estimated cost of this complete double track bridge is £244,000.

OIL INDUSTRY BROCHURE.—We have received from the Petroleum Information Bureau, 29, New Bond Street, London, W.1, a booklet with the title "The World of Oil," which the Bureau has just published. The booklet gives a broad outline of the oil industry, commencing with the birth of the industry and the formation of oil deposits and then continues with a description of exploration methods and of drilling techniques. Production questions are touched upon and there is a brief note about pipelines followed by a section dealing with oil tankers. Maps and diagrams illustrate the general principles of refining and a flow chart shows some of the processes involved to obtain a range of end products. The next subject dealt with is chemicals from petroleum, while drawings call attention to the lesser-known uses of petroleum products. One or two aspects of research are reviewed and brief mention made of the inland distribution of products.

# Continuous Extrusion Press for Aluminium Sheathing of Cables

*An extrusion press for the continuous aluminium sheathing of cables has been developed jointly by British Insulated Callenders Cables, Ltd., and the Loewy Engineering Company, Ltd. The press consists of two horizontally opposed hydraulically operated cylinders with rams each of which extrudes a hot aluminium billet on to the cable passing through an extrusion chamber at right angles to the line of the cylinders. Extrusion is continuous except for an interval of about 14 seconds when the cable remains stationary while the press is recharged with two billets.*

LAST week we attended a demonstration of a new press for the continuous extrusion of aluminium sheaths on power cables, at the Prescot works of British Insulated Callender's Cables, Ltd. The press has been developed by this company in collaboration with the Loewy Engineering Company, Ltd.

The properties of aluminium as a material for the sheathing of power cables are well known* and in Great Britain considerable experience has been gained with the process of dieing down a tube of aluminium to form a close-fitting sheath on power cables. In the meantime, the alternative method of direct extrusion of aluminium sheaths has been the subject of experiment for some twenty-five years, but, until recently, the prospects of developing the process on a commercial basis have not been realised. It is believed that the new press, illustrated here, brings this goal within sight.

A few years ago, after close study of the problems involved and after much preliminary experimental work, British Insulated Callender's Cables, Ltd., concluded that the following conditions must be satisfied before the extrusion of aluminium sheaths could be accepted as a normal production process :—

(1) The method should be suitable for commercial grades of aluminium.

(2) It should be based on the use of solid billets.

(3) The extrusion temperatures should be low, preferably not exceeding 300 deg. Cent.

(4) The process should be capable of producing sheathed cables in long continuous lengths.

(5) Satisfactory welds should be produced between successive billets.

(6) Minimum charging time should be achieved to prevent overheating of the cable while stationary in the press.

(7) Avoidance of deformation and metallurgical features at "stop-marks"—that is, at each place on the sheath which is within the die when the cable is stationary for recharging.

Since no existing press combined all these requirements, B.I.C.C. and the Loewy Engineering Company, Ltd., set out to develop an extrusion press which would provide the facilities required. The result of their work is the "Alsheath" press (Fig. 1), made by the Loewy Engineering Company, Ltd., and installed at Prescot.

This press is believed to be unique. It is hydraulically operated with two horizontally opposed cylinders, each 45in in diameter, operating at a maximum pressure of 4280 lb per square inch, giving a nominal thrust of 3000 tons. Twin billets are extruded through a common core and die to give sheaths ranging from 1·4in diameter to 3·5in diameter. In Fig. 2 we show a simplified layout of the equipment.

Briefly the operation of the plant is as follows. Billets of commercially pure aluminium are loaded into a Wild Barfield electric furnace by a "pusher" type of charger as indicated on the right of Fig. 2. The furnace accommodates ninety-six billets arranged in six rows. The billets are heated to 285 deg. Cent. and are discharged, by push-button control, in pairs, one on each of the two roller conveyors. Each conveyor is fed by three rows of billets, as can be seen from Fig. 2, and the billets are discharged simultaneously in pairs from the corresponding rows in each group of three rows. Each conveyor is made up of inward tapering, double conical idler rollers, over which the billet rolls longitudinally, by gravity.

From each conveyor the billet is discharged on to a loading platform. The two loading platforms, one on each side of the cable to be sheathed, are then raised simultaneously by hydraulic rams to bring the billets exactly opposite to the right- and left-hand openings of the extrusion chamber, as can be seen from Fig. 2. The two billets are then forced into the extrusion chamber by the simultaneous operation of the two horizontally opposed hydraulic rams. As each billet enters the opening a 30in vacuum is applied to the extrusion chamber to remove entrapped air that would otherwise affect the quality of the extruded sheath. At the same time, the flow of cooling water around the extrusion dies is augmented to obviate the risk of charring of the cable insulation while the cable is stationary for a few moments during the charging period.

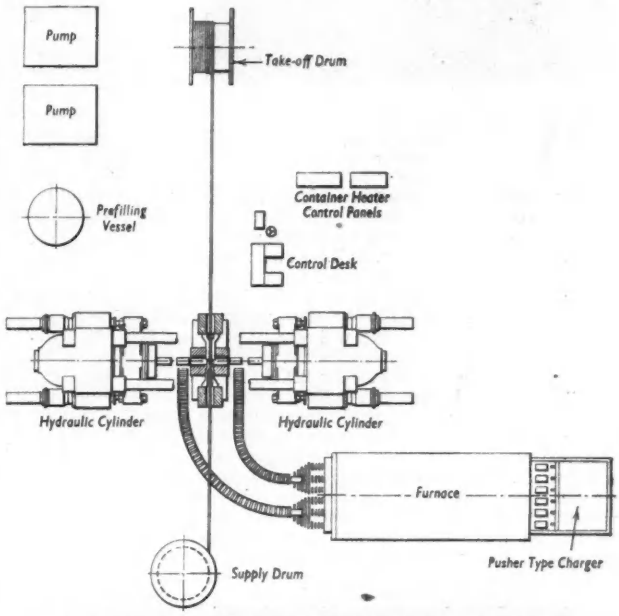



**Fig. 2—Simplified plan of extrusion press and associated equipment omitting the water bottles, air bottles and compressor**

During extrusion the cable passes from the supply drum through the core and die, where the sheath is extruded, and on to the take-off drum (Fig. 2). The surface of the paper insulation is oiled before entering the extrusion chamber to provide a heat-insulating film and avoid charring. The extrusion process is continuous except for the billet recharging period, when the two rams are rapidly withdrawn and when the cable remains stationary for about fourteen seconds. The extrusion tools are held in position by auxiliary hydraulic rams and are mounted in such a way that they retain their positions with a constant gap, independently of deformation resulting from temperature effects. The extruded sheath is therefore free from weakness at "stop marks" (Figs. 3 and 4). Balanced speed of extrusion from the two sides of the chamber is achieved by special controls.

All major movements of the press are controlled by servo-operated valves from a central control desk (Fig. 1), which provides for fully automatic control or individual control, as required. Under automatic operation the sequence of movements of the press is determined by limit switches actuated by the movement of the two rams.

Each of the cylindrical containers of the extrusion tools is electrically heated and thermostatically controlled, the temperatures being measured at six points on each container. The Kent temperature control panel can be seen on the extreme right of Fig. 1. This illustration also shows, in the background, the prefilling

* THE ENGINEER, Sept. 26, and Dec. 19 and 26, 1952.

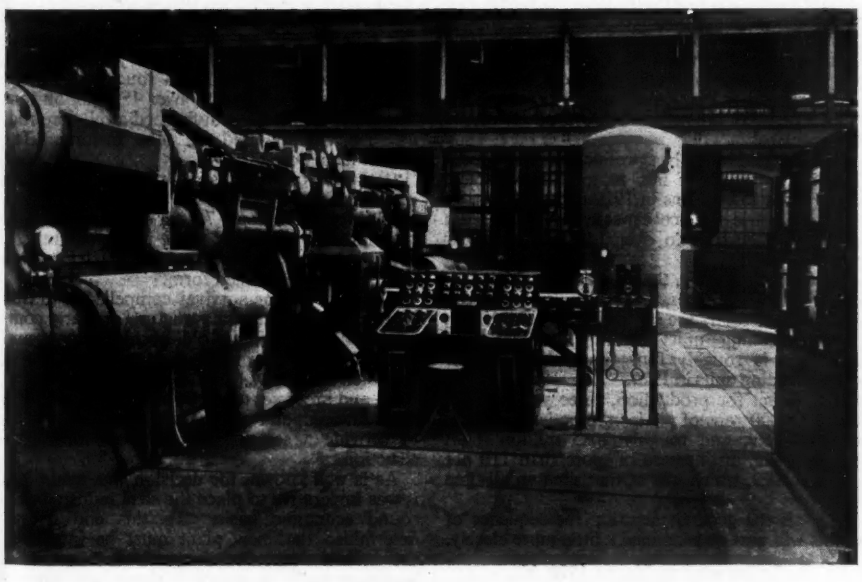


**Fig. 1—Extrusion press and associated equipment. The control desk is in the centre and the heater control panels for the container are on the right**

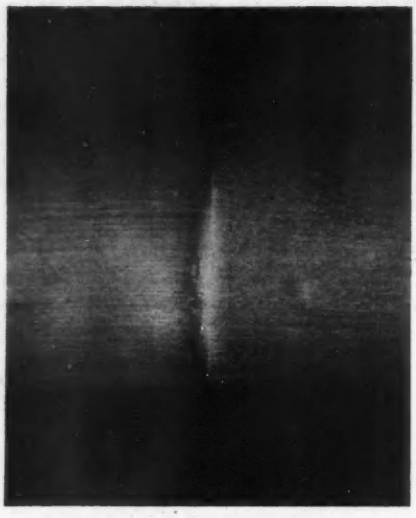


Fig. 3—"Stop mark" after bend test involving four bends over mandrel of 24 times the tube diameter

vessel; behind it is the water tank and, to the left are the two water bottles. The hydraulic cylinders are supplied by two geared pumps, each driven by a 230 h.p. B.T.H. a.c. motor controlled by an Allen West starter.

Trials to date indicate that all the initial objectives are being met and the press is approaching the stage when it will take its place as a routine tool in cable manufacture. Enough cable has been sheathed to satisfy B.I.C.C. that the "stop-marks" are satisfactory from the dimensional and metallurgical aspects; that they comply with the appropriate bend test requirements, and that they can withstand high hoop stress. Figs. 3 and 4 show the effect of bend tests on a specimen cable.

The welds formed between successive billets (as distinct from "stop-marks") are not discernible in the extruded sheath. Photo-micro-

Fig. 4—Photograph of "stop mark" during test to destruction

graphs show that the top and bottom welds, inherent in any right-angle extrusion, resemble those formed in the conventional lead press.

With aluminium of 99·8 per cent purity and extrusion temperatures of 280 deg. Cent., the extruded sheaths are in the lightly annealed condition. Tensile strength is 5·0 to 6·0 tons per square inch, and elongation on a length of 2in in the longitudinal direction of the sheath is 30 to 50 per cent, depending on diameter and thickness. The grain size is fine at all parts of the sheath, including "stop-marks." These properties ensure that the springiness associated with cold working is very largely eliminated.

The process as demonstrated last week is not yet established for the commercial production of a range of aluminium-sheathed cables. Much remains to be done in equipping the press with the tools required for a comprehensive range of cable size and in proving its performance over that range. Sufficient has been done, however, to indicate that the technique described offers a practical solution of the problems of continuously extruded aluminium sheathing which have engaged the attention of cable makers and of press designers for many years.

# Development in the Iron and Steel Industry in Great Britain

By T. P. COLCLOUGH, C.B.E., D.Sc., M.Met., F.R.I.C.*

*The seventh Hatfield Memorial Lecture was delivered by the author on Wednesday, May 26th, at the Royal Institution, London. Some excerpts from it are here printed. The lecture shows how, after experiencing depressing conditions following the 1914/18 war, the industry energetically set about re-equipment and reorganisation during the 'thirties. War experience between 1939 and 1945 is mentioned, attention is given to the reconstruction of the industry since the end of the war and, finally, some mention is made of the future.*

IT is significant that no vital new principle for the making of iron or steel, or for the rolling and shaping of steel, has been discovered during this last quarter century. The characteristic feature has been the application of scientific knowledge to the industry, based on an intensive study of the principles underlying the processes employed, with a resulting far greater knowledge and better understanding of the operations involved. On the one hand, this has led to a marked improvement in the efficiency of the manufacturing processes themselves, a raising of the general standard of quality, and the development of many new types of steel with specialised properties. On the other hand, the inventive genius of the engineering section of the industry has been devoted to the application of scientific knowledge to the development of larger and more efficient units of production; the mechanisation of plant with its reduction of manual labour; the greater use of electric power to replace steam as the source of energy and to replace raw fuel for melting and other purposes, and the development of instruments to give better control and greater precision to the manufacturing operations and, by reducing the dependence upon human judgment and reaction, to effect a remarkable increase in the speed and accuracy of operation.

These developments have demanded and made possible a complete change in both the general lay-out and detail of the manufacturing operations, and this in turn has demanded considerable and important changes in the commercial and administrative organisation. It may be of interest to mention briefly a few salient examples of the changes which have taken place.

In 1929 there were roughly 400 blast-furnaces in existence in this country. About one-half, or 200 furnaces, had an average capacity of 400 tons per week—totalling together a capacity of, say, 80,000 tons per week. To-day, eight operating furnaces have a capacity of over 50,000 tons per week, and when four other furnaces, at present under construction, come into operation the twelve furnaces are scheduled to produce 83,000 tons per week.

In steelmaking, the production per open-hearth furnace year has more than doubled, rising from 15,000 tons in 1929 to 39,000 tons in 1953. Electric furnace capacity has risen from about 100,000 tons to over 1,000,000 tons per year.

In the rolling mills, the growth in number and capacity of the continuous mills has been phenomenal and the capacity of the latest primary rolling units recently brought into operation is roughly four times that of their corresponding units in 1929.

The target for production, three years hence, is 15,000,000 tons of pig iron, practically double that of 1929, and roughly 20·5 million ingot tons of steel, an increase of more than 110 per cent on 1929, which was at that time an all-time record.

That is the general picture; the sequence of events will now be examined a little more closely.

## Conditions in Years 1920–29

The years 1920–29 marked one of the most difficult periods in the history of the industry. The artificial demand of the war years 1914–18 had seen the installation of steelmaking and rolling plant far in excess of the normal growth of requirements. Much of the new plant had been built to meet the emergency conditions at relatively high capital cost and was unsuited for normal commercial requirements. In addition, many old units of production, which normally would have been due for scrapping, were retained. As a result of the financial, economic and industrial conditions after the war, the demand for steel fell away and many plants were either closed down or operated below capacity.

The realistic as distinct from the nominal blast-furnace capacity in 1920 may be assessed at about 10,000,000 to 11,000,000 tons. The production during the ten years 1920–29 averaged only 6,000,000 tons, or even omitting the two years of prolonged strikes, 6·87 million tons—not more than 60 per cent of capacity.

In the steelmaking plants, the capacity in 1920 may be estimated at about 12,000,000 tons, whilst the average production over the ten years was only 7·36 million tons, or, again, roughly 60 per cent of capacity. The position was aggravated by severe competition from the Continent, particularly during the second half of this period. A large amount of new plant was installed in Western Europe, fostered by reparations and American investment, and the surplus output from these new plants was dumped in Britain.

During this ten-year period the imports of steel averaged 2·08 million tons per year, or the equivalent of about 2·6 million tons of ingots. It may be estimated that, in spite of the general state of industrial depression in this country as a whole, the demand for steel averaged about 9·9 million tons per year, but of this amount only 7·36 million tons per year were actually made in this country—26 per cent of the steel required was imported. During the five years 1925–29, the total steel imported was roughly 3,000,000 tons per year, and of this over 1·5 million tons were in the form of semi-finished steel, wire rod, or strip, mainly used for tube making. The salient facts were:

(*i*) Much of the existing plant was old and obsolete.

(*ii*) Not more than 75 per cent of the steel requirements was being made in this country.

(*iii*) About 50 per cent of the steel imported was in the semi-finished form.

The struggle for survival compelled a drastic revision of the financial structure of many companies, the scrapping of old, obsolete plants, and the closing of some works. Above all, it led to an intensive study of the methods by which plant and processes could be improved, operating costs lowered, and general efficiency raised so as to provide a sound financial basis for reconstruction.

As is well-known, the decision was made that it was imperative to place the steel industry on a sound economic basis. To this end it was determined that new plant must be installed; the industry must be reorganised to establish operating units of economic size; the imports of steel must be controlled, to prevent the

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unfair competition from abroad ; and facilities should be created to provide at reasonable rates the financial resources necessary for the reconstruction projects.

The steps taken to accomplish the provision of financial resources and the reorganisation of the industry as a whole are not within the scope of this review ; attention can be given only to the progress made within the industry.

### Reconstruction

From the practical aspect, the last twenty-five years fall naturally into three divisions—the pre-war, war, and post-war years.

The ten years 1930–39 can be regarded as a period of experiment and tentative progress, the war years were perforce relatively static, and the post-war years have marked a period of rapid and extensive development based on the knowledge and experience gained in the earlier stages.

### Pre-War Years (1929–39)

The experience gained in this country and abroad during the years 1920–29 had demonstrated clearly the inherent advantages of integrated operation.

The transfer of metal from one operation to the next while still in the liquid or hot condition made possible marked reductions in the cost of fuel and inter-departmental transport. The close association of coke and iron making gave a wider field of application of the valuable coke-oven and blast-furnace gases to the steelworks operations, thereby reducing the demand for raw coal and replacing it by a fuel which could be more readily controlled and more efficiently used.

As a result, certain principles were formulated as a basis for the reconstruction programme. These were :—

(*i*) The new plants should, wherever practicable, be integrated from raw coal and iron ore to the production of rails, heavy sections, plates and semi-finished steel.

(*ii*) Coke and pig iron production should be centralised ; the use of blended coal mixtures for coke making should be extended and the new coke ovens should be designed for under-firing with blast-furnace gas.

(*iii*) Blast-furnace practice should be improved by the grading of the ores and sintering of the fines.

(*iv*) Pig iron production should be assured a sound long-term basis by consolidation of the available home ore reserves.

(*v*) Steelmaking and rolling operations should be concentrated to the point at which the production would be adequate for large-scale, low-cost operation.

(*vi*) The operations of the primary steelmakers should be extended by the acquisition of certain re-rolling or finishing operations, so as to complete the integration of operations and provide an assured outlet for capacity production direct to the final customer.

(*vii*) In determining the location of improvements or new installations, special regard should be paid to the freight costs involved in the assembly of the raw materials used and in the dispatch to market of the finished products.

These principles furnished the fundamental bases for the modernisation of the industry.

### War Years

Development during the war years 1939–44 showed quite a different pattern from that in the years 1914–18. In the first war, steel productive capacity was expanded as rapidly as possible and, as is well known, led to considerable difficulties in post-war years. In the second war it was, for several reasons, deemed expedient to concentrate efforts in this country on the production of vital steels and to provide all possible expansion overseas.

The first obvious result was that, whereas the overall steel production in the U.K. in 1918 was 1·87 million tons (or 24 per cent) higher than in 1913, the maximum steel production during the second war was never substantially above that of the peak pre-war year, 1937. On the other hand, there was a marked change in the pattern of the quality of steel made. This is demonstrated by two salient factors, the development of electric furnace production and the increased production of alloy steel. In the years 1937–38 the production of electric steel averaged about 220,000 tons, or 1·9 per cent of the total steel made. This rose to a peak tonnage in 1943 of 990,000 tons, or 7·5 per cent of the total production—a fourfold increase. In addition, a marked contribution to the war effort was made by the change-over of several of the open-hearth steel makers from ordinary commercial qualities to the manufacture of alloy and special steels. The production of alloy steels rose in 1943 to a peak figure of 1·6 million tons, or over 12 per cent of the total steel production. Mere figures, however, are totally inadequate to present the true picture of the real development which British technical men and operators made in regard to quality during this period, and still fully maintain. This work placed Britain in a pre-eminent position in the manufacture of the highest qualities of steel, and it is to be hoped that the full story will be placed on record by a competent authority.

Probably the two most important factors emerging from the war years were (*a*) the experience of these years demonstrated the soundness and economies of the pre-war projects and provided a solid foundation for further developments ; and (*b*) the co-operative efforts imposed by war conditions proved the necessity for, and benefits to be derived from, joint discussion and co-ordination of effort to solve the common problems. This second factor applied particularly to the need for ensuring adequate supplies and correct distribution of the essential raw materials, which led to the establishment of a central body for the purchase and distribution of imported ore and the strengthening of the organisation built up before the war for the control of the scrap and steel required to fill the gaps in the home market. It was also advisable further to improve the arrangements made in the pre-war period for the joint examination of the development programmes of individual companies in the light of probable market demands, to ensure that estimated requirements would be met in the most economic manner, and, at the same time, to avoid unnecessary capital expenditure and wasteful competition.

### Post-War Development

Before the end of the war discussions were initiated for the preparation of an agreed development programme. The principles underlying this forward policy and its broad outlines were agreed by December, 1945, and were published in the Command Paper of May, 1946. This document is too familiar to need recapitulation, but it may be of interest to review briefly how far and in what manner the objects set forth in that programme have been attained.

The primary objects of the Five-Year Plan, of which the principal projects were to be initiated by 1951 and completed by 1953, were :—

(*a*) To increase steel production to about 15,000,000 tons per year—an increase of 3,000,000 tons (or 25 per cent) over the pre-war maximum of 1937.

(*b*) To install about 5,000,000 tons of iron and steelmaking plant of modern design.

(*c*) To install the most efficient design of rolling mills.

(*d*) To consolidate production in units of economic capacity and embodying the most recent methods of manufacture.

### Post-War Production

The production target of 15,000,000 ingot tons was achieved by 1949 and has been surpassed in each succeeding year. It was soon recognised that the target figure, optimistic as it appeared at the time, was not adequate to meet the growing demands of the country. After discussion with the Government Departments concerned, it was agreed that the target should be raised to 18,000,000 ingot tons, to be achieved by the mid-1950s. In every year except 1951, when there was a sharp fall in receipts of imported scrap, there has been a substantial increase in production. The production for 1953 was 17·6 million tons, and the present target is for a production of about 20·5 million tons in the years 1957–58.

### Research

No survey of the developments of this period, however inadequate, could fail to refer to the growing importance and influence of research. Development in this field owes much to the efforts and example of the late Dr. Hatfield, to whose memory tribute is paid to-day. The activating force in his valuable work was not solely an endeavour to discover new facts or new steels, but was primarily the application of scientific facts and the scientific method to the study of works' problems, and to give a sound, fundamental basis to the different manufacturing operations and processes.

### The Future

Although the subject of this review is development over the last twenty-five years, it will be appreciated that development is not a static process. To be effective, it must be activated by a continuous and definite policy, with due regard to both immediate requirements and long-term trends.

More than once some doubts have been expressed as to the wisdom of the expansion at present in hand. Not yet, however, has steel production attained the level at which the steel requirements of the country can be fully met. On the other hand, there can be no doubt that if this country is to maintain its economic stability and if the demand for a higher standard of living both in this country and overseas is to be met, further expansion is imperative.

Competent authorities have estimated that, on the average, provision must be made for an increase of 2½ per cent per annum in British steel production. In the course of ten years this would amount to over 25 per cent, and, taking the forward view, it is not unreasonable to suggest that the steel production of this country should be raised to about 25,000,000 ingot tons by the middle 1960s. It is not to be anticipated that the increase will be uniform over all types of product. So far as can be visualised at the moment, there will be a more marked increase in the requirement of flat rolled products and bars and other forms required by the engineering industry.

This prospective increase raises the question of adequate supplies of raw materials. There can be no doubt that new resources of iron ore are available if development is put in hand. This additional ore, in general, is at somewhat greater distances from this country, and additional and improved forms of transport must be provided. For economy, it is essential that this ore shall be carried in the largest practicable type of ore carrier. It will be agreed that the present size of ship being built leaves much to be desired if the maximum economy, especially on long hauls, is to be achieved. It is urgent that steps should be taken immediately by the dock authorities for the further improvement of unloading facilities and the provision of berths for ships of deeper draught at, at least, four of our principal ore reception ports.

It is evident that the supply of suitable coal will present some difficulties. Here again, research should be concentrated on methods of attaining greater fuel economy, and a study should be made of the possible extension of the use of fuel oil for heating purposes in steel works.

It will be agreed that one contributing factor to the overall problem is the relation between the steel and gas industries. If the total supply of coal suitable for carbonisation is limited, it may well be desirable to consider a further extension of the transfer of coke-oven gas from the steel industry's ovens to the gas industry. The establishment of wider-spread gas grids could do much to lower the demand on the available coking coals and add to the general overall economy.

The real essence of the development of the last twenty-five years is the creation of a new spirit and of a sense of unity within the industry which never existed previously. The discussion in common (at all levels) of individual difficulties and general problems, the sharing of individual discoveries, the joint formulation of requirements and the means to provide them, the readiness to help those in special difficulty, and the willingness to modify individual proposals in the light of the common need are the real essence of the progress made. So long as this spirit pervades the activities of the steel industry, the needs of the country will be met and the well-being of the industry ensured.

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## LET US NOW PRAISE FAMOUS MEN

Next Sunday the centenary of the birth of Sir Charles Parsons falls to be celebrated, and in this issue we publish a short article reviewing his work. In Newcastle, next Monday, there will be opened a Parsons Centenary Exhibition, and Professor Burstall will read an address on "The Place of Sir Charles Parsons in the History of Mechanical Engineering." It is very fitting that at such a moment attention should be directed to the work of so great a man. Yet in fact there is very little that is unfamiliar that can now be said or written about that work or about the character of the man who did it. Almost everything there is to know about Parsons has been recorded in books or in the remarkable series of Parsons Memorial Lectures, the latest of which is due to be presented before the Institution of Mechanical Engineers later this year. It is, indeed, significant that those lectures, delivered, as they are, annually, tend nowadays to deal, not with Parsons' own work, but with up-to-date developments in fields in which Parsons made advances in the past. Nor is it possible at this centenary to make any new appraisal of the achievements of the great man whose birth we celebrate. His worth, his genius and his capacity were indeed already well recognised when, loaded with honours, he died in 1931.

Yet we cannot look back upon the work of such a man wholly unmoved. For whence come men of his kind ? How comes it about that in every generation a few men are born who, in ability, stand head and shoulders, not merely above the common ruck, but high above even the talented men of their own day ? Their characters, their interests, their methods vary widely. Leonardo da Vinci was a social butterfly as well as a great artist, a scientific thinker and an engineer ; Watt a rather dour Scot ; Stephenson a typical "geordie" ; Trevithick a mercurial Cornishman full of often wild enthusiasms. How different they all are from one another and from Parsons ! Yet all had in common not only the power to think along lines often beyond their contemporaries' immediate understanding, but also to bring their conceptions to reality. To-day it may be argued that great advances, such as those men made, can no longer be expected through the works of individual men of high talent ; that development has become so complex a business that only through the work of teams and the direction of committees can the ground be surveyed and useful work be begun. There is, of course, a grain of truth in that submission. But how far it misrepresents the whole of the truth ! For no team, no committee ever produced or could produce anything creative and advanced unless there was amongst its members some individual with creative powers. The bringing together of a group of ordinary men can lead to nothing more than an integration of ordinary ideas. Had a committee of engineers of ordinary ability examined in the early eighties of last century the possibilities of the steam turbine, would it not have concluded, as most engineers of the day had already concluded, that the device, though promising in theory, was impracticable of realisation ? Fertile ideas are individual things. They make their appearance in individual minds. Nor do we believe they come from sudden and unexpected flashes of insight "out of thin air." They arrive as the consequence of hard study of the fundamentals of a problem and hard thinking about them thereafter ; combined with an unwillingness to accept as gospel the opinions of other men, however high their reputations, without personally subjecting them to critical analysis. Nor is that all that goes to the making of such great minds as that of Parsons. Outstanding men in engineering, if not also in other fields, have proved to possess a surprising ability, even in the face of initial antagonism, of inspiring others with their own faith and their own determination ; and they have attracted around themselves groups of men who have proved only less talented than themselves. Ideas come to many men. It is not only the great who have them. Parsons did not "invent" the steam turbine, any more than Watt "invented" the steam engine or Stephenson the locomotive. But each of them had such an insight into engineering mechanism and such an understanding of the play of natural forces that they lifted the devices with which their names are principally connected on to wholly new planes of practicality. Each of them was steadfast in the face of setbacks ; each exhibited insight and ingenuity in overcoming difficulties ; all had an immense capacity for hard work. It is, indeed, not fecundity in ideas alone that makes great men. Other qualities of mind are also wanted.

So, as the centenary dates fall due it is fitting that we should take the opportunity so provided to praise famous men. Conditions may change. The boundaries of human knowledge have expanded so vastly and continue so rapidly to extend that it cannot be expected that ever again a man like Leonardo will arrive capable of making fundamental advances in painting, sculpture, warfare, medicine, science and engineering. Nor, in all probability, could a great man again be born to make advances in the fewer yet still widespread fields associated with the name of Parsons. So vast, in fact, has become the estate of human knowledge that its boundaries can be reached only through long and intensive study of specialised fields. Advances, therefore, upon any wider front must be made by teams of specialists rather than by individuals. But, fundamentally, there has been no change. Fecundity in conception, determination against discouragement, faith, energy and firmness of purpose are individual, not collective, qualities. No team, however otherwise well chosen, can make great advances unless it has amongst its number at least one greater man to inspire creativeness amongst the rest, to fire enthusiasm and to select by some touch of genius, as such men do, which among many conflicting paths will lead most directly and most simply to the desired end. Over the past two centuries and more this country has produced, more particularly in the fields of science and engineering, a galaxy of famous men. If it is to continue to prosper in the future it will need to breed them as profusely as in the past. We do well, then, to honour famous men who have lived and died amongst us. Their exertions conferred great benefits upon this nation. Their inspiration lives after them. "For their work continueth . . . greater than their knowing."

## COASTAL FLOODING

Last week, the Waverley Committee—or the "Departmental Committee on Coastal Flooding," to use its full title—published its report and recommendations. Many engineers who have been concerned with the rebuilding of the sea defences along the East Coast of England—that vast civil engineering undertaking which has been in progress since the early spring of 1953 and is now virtually complete—will have been awaiting with interest the publication of this report. With the exception of a proposal for flood protection in the Thames basin,

its conclusions do not embody novel ideas of sea defence, but, very generally, endorse the standards of design and construction adopted by the river boards last year, pointing out, however, a number of technical factors which are considered important. But the committee's report also draws attention to those subjects, some of them fundamental to successful sea defence, where existing knowledge is inadequate and further research is urgently needed—for instance, in studying the movement of beach materials and the action of groynes. Proper co-ordination of research is also stressed, including co-ordination with Dutch authorities. We also print with this issue a Supplement in which an account is given of some of the Dutch sea defence works, including a note on the recommendations of the "Delta" committee; the construction of a series of dykes to connect together the islands of South Western Holland is proposed by that committee, thus reducing the length of the first-line sea defences in the area to a small fraction of their present extent, permitting reclamation and obviating the saline contamination of ground water. The Waverley Committee's tentative proposal for a flood prevention structure in the Thames offers an equally imaginative solution to an analogous problem, but, of course, the conditions are very different in the two cases.

The Waverley Committee bases its report on the assumption that, for the protection of human life, reliance must be placed on an effective warning system. Recommendations for such a system were made in its interim report and it considers that if the precautions recommended then could have been taken at the time of the flood of January 31, 1953, loss of life would have been reduced to a minimum, if not averted altogether. In considering the margin of safety for sea defences, therefore, the report states, the committee had the protection of property mainly in mind. The conclusion was that the maximum standard of protection, for property of high value, should in general be sufficient to withstand the flood of January, 1953, and elsewhere, a standard which would reasonably have been thought adequate before January, 1953, would suffice. No major changes and no new legislation were considered necessary in the administration of sea defences and in the organisation of the various public bodies and Government Departments responsible for them, nor in the financial provisions for such works, save that a grant for maintenance was proposed. Various relatively minor improvements were suggested, however. Flood protection of the Thames, particularly in the London area, was considered as a special case, needing legislation, but to this the same general principles would apply.

Sixteen months after the occurrence of the 1953 flood, with the great effort of reconstruction completed, it might be asked if the Waverley Committee's report has not appeared rather too late. It cannot be denied that guidance on general principles, of the kind given in the report, would have been of value to the engineers concerned in the design of the new works which have now been erected all along the East Coast. But these principles have been deduced by the committee from evidence supplied from many authorities and diverse sources and, in fact, they embody much of the experience gained during last year's period of intense activity. Even with all the resources which it had at its disposal, the Waverley Committee could not gather by any means as much information as it evidently needed; the influence of the Institution of Civil Engineers' conference on the East Coast floods held last December, when there was a very full exchange of technical views, is apparent in the report, as is also the lack of knowledge of some topics. Much of the report's value lies in the comprehensive account which it gives of all the aspects of the problem of coastal flooding—the meteorological, the technical and the administrative and financial aspects—directing attention in every case to the shortcomings of existing arrangements and the gaps in existing knowledge. Thus, by indicating where improvements can be made, and where research into technical questions—upon which success ultimately must depend—can be most profitably applied, the recommendations of the Waverley Committee, will, when implemented, be of great value to the coast protection engineer, and will give him basic guidance for future policies of research and construction.

## Literature

*Fundamentals of Physical Metallurgy.* By RALPH HULTGREN. London: Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, W.1. Price 70s.

THIS is essentially a book for students entering upon a course in physical metallurgy, and was apparently written as a textbook covering more than sufficient material for a one-year course. As a 400-page book of this character its cost is high. The theoretical treatment of the subject proceeds on lines which can readily be followed by anyone having an elementary knowledge of physics and chemistry; but some sections—for example, the discussion of equilibrium in terms of fugacities and the derivation of the phase rule—make a rather unexpected inroad into the subject of physical chemistry and would seem to be out of place, especially as the author states that such parts can be omitted if necessary without handicapping the reader in the later chapters. It would seem that on such matters a statement of conclusions, without detailed treatment, would have been more appropriate. The emphasis throughout the book is on metallography, interpreted in the widest sense. Study of crystal structure, phase changes and possible modifications of microstructure is essential in the development of alloys of superior mechanical and physical properties. These subjects and all that they imply in the understanding of problems of heat-treatment and fabrication occupy much of the book, which is well illustrated by diagrams and many excellent photomicrographs. The author, who is Professor of Metallurgy in the University of California, evidently desires to impress on his readers the inter-related interests of metallurgists and engineers. This possibly accounts for the fact that the subject matter tends to overflow the bounds normally set by books on physical metallurgy, and comprises a good deal of information about the technique of casting, mechanical treatment, heat-treatment and welding. These subjects are introduced to illustrate underlying principles and to clarify the theoretical discussion by practical examples. With the same object in view, problems, often numerical in character, are appended to many of the chapters. The book should appeal specially to students whose interests lie on the engineering side of metallurgy.

## Letter to the Editor

*(We do not hold ourselves responsible for the opinions of our correspondents)*

### UNIFIED SCREW THREADS

SIR,—In reply to the letter of Mr. Conway, in your issue of May 28th, regarding Unified screw threads, if he had troubled to read my letter thoroughly he would have seen that rounded roots and crests are used on American threads when required and also that it was agreed an interchangeable thread was advisable for armaments.

He maintains that the Unified thread is new, which seems rather sweeping. Merely rounding the roots and crests of the American thread does not change it into a new system any more than truncating a Whitworth thread could be considered as introducing another new system. In both cases the pitch, angle and effective diameters remain the same.

His last paragraph would not carry much weight with users of screw threads. By copper threads I presume he means the thread for copper tubes, which is a pipe thread and outside this discussion. Can he produce any instance where the cycle thread of 60 deg. is used in normal engineering practice, other than for cycles and motor-cycles? Even with this thread the Whitworth form is used for certain pitches quite frequently.

The B.A. thread of 47½ deg. has no equivalent in the British Unified system, so that it is pointless bringing this in. The American equivalent of "Number Threads" in coarse and fine series are, however, included in their Unified system. With the Whitworth form of 55 deg. angle we have the B.S.W., B.S.F. Brass and B.S.P. parallel, four series of thread pitches with three different classes of fit. The Americans have six series of thread pitches (excluding the two Number series) with five different classes of fit. Does he still say our system is more complicated?

For armament purposes it is immaterial what thread is used, providing all parties agree, but the matter is different in the commercial field, where objections to having the American thread forced upon us can be raised; particularly as the attempt is being made by camouflaging it under another name.

Can an answer be given to the question as to how many Whitworth form threads are in use in the world outside Great Britain compared with the number of American threads in use outside the U.S.A.? Considering the long start we had with our exports before being challenged by the U.S.A., this is a moot point. Apart from this, advertisements have appeared for sets of spanners for the "New Unified thread." How many firms have bought these in the belief that a new size has been introduced?

Will Mr. Conway please state on what grounds he considers the American thread so superior to the Whitworth, as a bare statement to this effect is not very illuminating. It will also be of interest if he will give a constructive explanation of the "errors in fact and implication" in my letter. He is obviously in a position to do this—let him do so.

BRYAN B. BATEMAN

Liverpool, June 3rd.

## Books Received

*The Grinding of Steel.* By E. N. Simons. London: Odhams Press, Ltd., 96, Long Acre, W.C.2. Price 25s.

*The Master Engineers.* By Emmeline Garnett. London: Hodder and Stoughton, Ltd., St. Paul's House, Warwick Square, E.C.4. Price 12s. 6d.

# Report of the Waverley Committee

THE report of the departmental committee on coastal flooding—the Waverley Committee—has now been published by Her Majesty's Stationery Office. The committee was appointed in April of last year, after the disaster caused by the storm and tidal surge at the beginning of February, with the following terms of reference : (i) " to examine the causes of the recent floods and the possibilities of a recurrence in Great Britain ; (ii) to consider what margin of safety for sea defences would be reasonable and practicable having regard, on the one hand, to the estimated risks involved and, on the other, to the cost of protective measures ; (iii) to consider whether any further measures should be taken by a system of warning or otherwise to lessen the risk of loss of life and serious damage to property ; (iv) to review the lessons to be learned from the disaster and the administrative and financial responsibilities of the various bodies concerned in providing and maintaining the sea defences and replacing them in the event of damage, and to make recommendations."

An interim report was made by the committee in July of last year, on the third of its terms of reference, and as a result a flood warning system was in operation along the East Coast last winter. This interim report is included as an appendix to the present report, but is enlarged upon in that further research is recommended, as an urgent measure, to study storm surges in the North Sea and hence to increase the efficiency of the warning system. In the following paragraphs we have abstracted certain passages from the body of the report, which include the committee's principal recommendations. The report opens with an account of the causes of tidal surges, of relevant tidal and geophysical conditions, and of the damage caused last year.

We have described the East Coast, the report goes on, and stated what damage occurred, and we have now to consider the defence problem as a whole. We can distinguish between those defences coming within the responsibility of the River Boards and the coast protection authorities respectively. Coast protection authorities are concerned mainly with the protection of towns and villages situated on land, the level of which is above the highest sea level, and with the prevention of erosion. River Boards are concerned with the defence of low-lying land against flooding. Sea defences in this category can be conveniently considered under two heads : (*a*) those formed by Nature, sometimes partly assisted by man ; and (*b*) those formed entirely by man. Obviously natural defences can be made use of only where conditions are favourable to their natural development. Little assistance can be given to them except in respect of sand dunes. The behaviour and suitability of various plants for use on sand, shingle and other material adjacent to the sea has not in our opinion received as much study as the importance of the subject merits. We recommend that further research should be taken in hand without delay.

Whilst investigations are already in hand in regard to the movements of beach material, offshore sandbanks and related coastal problems, notably by the Hydraulics Research Board, and arrangements are being made for periodic field surveys by River Boards and coast protection authorities, we feel it necessary to emphasise strongly the importance of ensuring vigorous pursuit of research into those problems. The matter is one of much complexity and requires the careful co-operation between those bodies who may be concerned in the collection of information, but the pursuit of further research should not prevent full use being made meanwhile of groynes in those localities where this is known to be an effective means of stabilising beaches.

There are a number of matters about the execution of works of sea defence on which we have received evidence and on which we think it appropriate to make recommendations. The first of these is the second line defence. In a number of places there are such defences consisting of earthen banks behind the first line of defence and in some cases they were constructed as first-line defences centuries ago. There are also examples of cross banks between the first and second defence line dividing the area liable to flooding into " boxed " compartments. We consider that, subject to examination of local circumstances, existing second line defences should be maintained and consideration might well be given to the construction of new second line defences, where the potential benefit justifies the cost.

We have heard that the serious after-effects of the flooding in January, 1953, would have been lessened if the flood water had been drained off rapidly everywhere. Whilst in some areas this was possible, in others appreciable delay occurred and it was sometimes necessary to cut the sea defences to release the water. We can only draw attention to the importance of this matter, particularly in those places where the standard of the defence works is such that the risk of some overtopping is accepted. We understand that since January, 1953, a number of tidal creeks in the Thames estuary have been sealed with the consequence that the embankments along these creeks are no longer necessary. There may be places where sealing off, not yet attempted, would be practical and economical. When the engineers of the East Coast River Boards gave evidence they stressed the great importance of having convenient access to the sea defences. There can be no doubt of the importance of this point.

We now turn to a recommendation which does concern technical design. It is clear that in some places the risk of overtopping must be accepted either because the cost of raising the defences is disproportionate to the value of the property to be protected or because, and this is a point which we must stress, the nature of the subsoil is such that it will not bear any additional weight. In these cases the risk of breaching might well be diminished if the whole of the top, face and back of the bank were protected by a waterproof carpet of some such material as asphalt. As there does not appear to be sufficient experience of the effectiveness or cost of such waterproofing, we recommend that the requisite investigations and experiments should be undertaken.

At a meeting of some members of the committee and representatives of the Institution of Civil Engineers, a questionnaire was designed with the object of eliciting, as far as possible, detailed information as regards the character and probable causes of failures of the defences and was circulated to the River Board Engineers concerned. We think that the replies should be analysed and that this analysis will be of use to the Government, the River Boards and the engineering profession.

We have made a number of recommendations regarding research and we think that steps should be taken to see that these researches are properly co-ordinated. Recourse might well be had for this purpose to the constitution of consultative standing committees. It seems to us that there might be scope for two such committees : one to co-ordinate oceanographic and meteorological research and a second to co-ordinate the researches designed to improve the sea defences. We understand from Dr. van Veen, the Chief Engineer of the Rijkswaterstaat, with whom we conferred, that research of a similar character is being undertaken in Holland. We are strongly of opinion that great benefit would accrue from close co-operation on both sides of the North Sea between scientists, engineers and Governments.

We cannot tell when a flood will recur. We have given the best estimate we can of how often it would recur, but as we have emphasised that estimate is purely statistical and based on a relatively short experience. The level reached last year was at least 1½ft higher than would have been expected on previous experience. In these circumstances it seems to us that the water level (tide plus surge) reached in 1953 should be taken in general as the maximum against which protection can reasonably be afforded. Indeed, since we are directed by our terms of reference to have regard to the estimated risks and the probable cost of protective measures, we could not recommend a higher standard. We think that where flooding would lead to serious damage to property of high value or would affect any large area of valuable agricultural land, the highest measure of protection should be given. We think that in those areas it would be right to aim at a standard of defence which would protect them from a flood like that of January, 1953, exceptional though this may be, and in other areas where the value of the property to be protected is not sufficient to warrant so great an expense, at a standard which would reasonably have been thought adequate before the flood of January, 1953. In laying down these standards we do not exclude the possibility of an even higher standard where the property to be protected is of exceptional value though we think that anyone requiring such a higher standard may reasonably be expected to pay for it himself.

We have been impressed by the fact that much of the damage done by the 1953 floods was the result of sporadic and ill-considered development near the coast. The machinery for preventing such development already exists under the Town and Country Planning Act, 1947. We think that all possible steps should be taken to prevent further undesirable development and that full use of the machinery of the Planning Act should be made. We understand that local planning authorities generally consult River Boards on suggestions for development which may involve drainage considerations including flooding. We must stress the importance of such consultation. Nevertheless, we cannot agree with the suggestion that was made that River Boards should be given further powers to prevent such undesirable development, since it appears to us that it would be wrong to give such powers to two types of authority, the local planning authority and the River Board.

*Flooding in the Thames.*—A considerable part of London was built on what was at one time marsh land and is below high tide level. The liability to flooding in this area and the damage to valuable property that might be caused thereby are of such importance that we feel that the problems arising deserve special attention.

We were fortunate in having had made available to us the Port of London Authority's tidal model of the river. Experiments upon the tidal model showed that if a high flood discharge of 20,000 cubic feet per second at Teddington had coincided with the high water of January, 1953, instead of the 2597 cubic feet per second actually recorded, the maximum increase in level in London would have been about 9in. Since the level reached in January only just avoided causing serious flooding, it is clear that even a small increase in fresh water flow would have made the position most serious.

It was represented to us that the nature of the defences in London was such that to raise them would be both difficult and costly as in many cases it would involve complete rebuilding of existing structures as opposed to merely increasing their height, and further a great deal of ancillary work would be necessary. Three methods apart from the raising of the defences have been suggested. One was to erect a barrier across the estuary, leaving gaps through which shipping would be allowed to pass ; we were advised that this would cause deterioration of the estuary. Another suggestion was that spill should be allowed to take place into specially prepared areas in the lower reaches of the river ; this would be inadequate even if it were practicable. The third method suggested was to interpose a suitable structure across the river between Purfleet and Greenhithe known as Long Reach. This structure would be provided with " gates " so as to leave the waterway clear except on the rare occasions of impending high flood.

The third method was investigated in detail by an experiment on the model. In this experiment a structure was lowered into the river to varying depths ; it showed that if by such means the waterway was closed gradually in thirty minutes, starting four hours before the expected arrival of the peak of the tide-cum-surge, to the extent necessary to reduce the water-

way by 90 per cent, maximum water levels at London Bridge would be lower by about 5ft. With this degree of closure, maximum water levels downstream would not be increased. This is clearly a most interesting possibility, but one which involves formidable engineering and financial considerations, and we do not think we can do more than set out the technical problem together with this suggestion which has been made to us for a solution. We think it important, however, that this suggestion should be investigated and a decision reached as quickly as possible, since the decision as to basic methods of protection will necessarily govern the executive works to be undertaken by the responsible authorities. The comparative cost and efficacy of the alternative methods of securing the necessary standards of protection for the London area, whether by raising the levels of protective works or by engineering works spanning the river itself, would require detailed investigation outside our province, but pending the results of such investigation, the standards of protection to be provided against flooding in the Thames should be determined on the same principles as elsewhere.

We should like to stress that in our view the need to introduce legislation to put the administrative and financial aspects of the Thames flood defences upon a satisfactory footing is urgent.

The report also noted that, in the committee's opinion, there should be no change in the present distribution of responsibilities for sea defence, and that no further legislation appeared to be necessary.

## Commonwealth Engineering Conference

THE Conference of Engineering Institutions of the British Commonwealth concluded its meetings in London on Friday last. These meetings began on May 24th, the Institution of Civil Engineers, the Institution of Mechanical Engineers and the Institution of Electrical Engineers acting as hosts. The conference is an advisory body providing a means by which views can be freely exchanged between senior officers of the Institutions concerned on the methods by which their Institutions can best work together to further the aims for which they are severally constituted. No less important, the conference provides opportunities for close personal contacts between eminent engineers of the countries represented. Each of the Institutions is autonomous, and in their voluntarily coming together to discuss their common problems the conference follows in the field of engineering the pattern of the friendly co-operation which exists between the sovereign nations of the British Commonwealth itself.

In the course of its ten business sessions the conference discussed a number of matters of interest to its constituent Institutions, their members and the public whom they serve. These ranged from such matters as the proper conservation of natural resources to more detailed questions touching the education and training of professional engineers, the assistance which the engineering profession can give to the provision of adequate numbers of fully competent engineering technicians, and measures to secure the most effective interchanges of lecturers and speakers on engineering subjects. Recommendations to the councils of the constituent Institutions were drawn up and when these have been approved by the councils they will be published in the journals of the Institutions. The delegates to the conference also participated in a number of social engagements designed to bring them into contact with representative British engineers, and to let them see examples of British engineering in the fields of education, industry and research.

At a dinner to mark the ending of the conference the visiting delegates expressed their appreciation of its work and their conviction that the decisions arrived at would be of great benefit to the engineering profession and to the public at large.

The next meeting of the conference is to be held in Australia in 1958, at the invitation of the Institution of Engineers, Australia, supported by the New Zealand Institution of Engineers.

# Centenary of Sir Charles Parsons

SUNDAY next, June 13th, will be the centenary of the birth of Sir Charles Parsons, whose name will live in history as that of one of the greatest of engineers. By his creation of the first practical steam turbine in 1884 and his wonderful developments of it for duties on land and sea, he brought about the most fundamental advance in the use of steam power since James Watt freed industry from dependence on waterfalls, windmills or sails, by the invention of the rotative beam engine just over 100 years before.

There is no need now to record the story of Parsons's life nor to do more than mention those aspects of his character that so many people still living will remember with admiration and respect. All who had dealings with him appreciated his absolute integrity and his scrupulousness in fulfilling to the uttermost every promise he gave, while his friends knew him also as one of the kindliest and most likeable of men. He had, nevertheless, a highly strung temperament that rendered him liable to occasional outbursts of irascibility—usually over some quite trivial matter—that might be really terrifying at the time to the members of his staff who had to endure them, though as soon as his wrath had subsided, the incident seemed to pass for ever from his mind. In the company of strangers he was diffident and he always shrank from the limelight. It was in keeping with the modesty of his character that he expected other people to possess a comprehension equal to his own, and he was always ready to discuss a technical point with anyone from a labourer upwards who had anything sensible to say. It apparently never occurred to him that his own achievements were at all remarkable or beyond the capacity of any competent engineer. He seemed to regard them merely as the logical applications of previous knowledge, and this attitude no doubt accounted for his confidence in making advances of a magnitude that would have been thought by most men to be rash in the extreme. Amongst them will be remembered the 70,000 s.h.p. turbine installations of the "Lusitania" and "Mauretania" in 1906, when the most powerful turbines afloat did not exceed 14,000 s.h.p.; also his construction of a 25,000kW turbo-alternator for Chicago in 1912 when 6000kW was the greatest capacity of any existing unit. In every case the results justified his boldness and bore witness to the soundness of his instincts.

The result of Parsons's work that can be most readily appreciated by the ordinary citizen is the phenomenal increase in the availability of electricity for domestic and industrial purposes that has taken place within living memory. His turbine was first used for the public supply of electricity in 1890, when he, with the aid of friends, established a central station in Newcastle, equipped with four 75kW turbo-alternators. At that time the aggregate capacity of all the central stations in the country did not exceed 22,000kW, and even the most economical of those supplying alternating current could not do it for less than 20 lb of coal per kilowatt-hour—a figure that may be compared with the fraction of 1 lb per kilowatt-hour that would suffice for a modern station. Ten years later Parsons made a pair of 1000kW turbo-alternators for Elberfeld Power Station, in Germany, which were certified by an international commission of engineers to have an efficiency higher than had ever been obtained by any reciprocating engine. By 1904 he was building units for outputs equal to the maximum capacity of the most powerful reciprocating sets, and after that the disappearance of the reciprocating engines from central stations was only a matter of time.

The victory of the turbine for naval duties was even more rapid and conclusive. The first turbine-driven warship was H.M.S. "Viper," a 370-ton torpedo boat ordered in 1898. She attained a speed of more than 37 knots on her trials, and by 1905, after experience with a few more turbine vessels, the Admiralty decided to adopt turbine propulsion for all future warships, starting with the 18,000-ton battleship H.M.S. "Dreadnought," then about to be built. By 1910, only sixteen years after the first appearance of the little "Turbinia," there were in service or under construction a total of 333 vessels equipped with Parsons turbines of 4,700,250 aggregate horsepower. Of these, 243 were warships for the navies of fourteen different nations.

Whether or not the public realise how much they owe to the work of Parsons, engineers alone can appreciate his genius as a designer and the importance of his contributions to technical science and practice. To have succeeded in his first attempt to construct a generating unit to run at the unprecedented speed of 18,000 r.p.m. and capable of giving useful service for sixteen years was indeed a remarkable feat, for, apart from the solution of the electrical problems involved, possible difficulties with vibration, lubrication and governing were all foreseen and provided against by special devices. Although the turbine was designed primarily for driving electrical generators, Parsons's foresight was shown by his earliest turbine patent, which included not only such duties as ship propulsion and pumping, but also the use of a turbine with reversed blading, as a compressor. What is even more striking was a claim for the employment of such a compressor to force air and fuel into a combustion chamber, and the development of power from the resultant gases by a turbine mounted on the shaft of the compressor. It was, in brief, the anticipation seventy years ago of the modern gas turbine. The development of Parsons machinery for central station work and industrial purposes on land until his death in 1931 was described in a series of articles in THE ENGINEER during 1934 and 1935, which were later republished in book form by Constable and Co., Ltd. Details were given of more than a hundred machines ranging from his first little turbo-dynamo to the 50,000kW reheat units at Dunston. Each illustrated some definite advance in design, and there was thus presented a very complete picture of the progress of the land turbine and of the various machines designed to be driven by it.

Many of Parsons's early inventions, including the sleeve bearings and the steam relay governing, which served him so well for twenty years or so, became obsolete with the increasing size of units and the advances in steam conditions, but the principles of his labyrinth packings (1889) and his steam-sealed glands (1891) have remained of permanent value. Among the early pioneering work that has influenced modern practice was his patent of 1894 for the use of an exhaust steam turbine in combination with a reciprocating engine, and his employment in 1896 of an aerofoil form of blading long before

there was any recognised science of aerodynamics. The form and spacing of the blades that he instinctively chose proved to be practically ideal for the velocity ratios used at the time, and for many years afterwards. He made experiments with the reheating of the steam between the cylinders of his first tandem compound turbine in 1900, but the benefit was so slight with the permissible superheat temperatures of those days that the commercial application of the reheat principle was deferred for several years. In 1916 Parsons made a really important advance in the thermodynamic cycle of the turbine by constructing a compound turbine for power station work, in which the steam was not only resuperheated between the cylinders, but partially expanded steam was also extracted at two different pressures for regenerative feeding. Thus he inaugurated a heat cycle characteristic of the most efficient power plants of to-day. Previous to this he had made an outstanding improvement in condensing practice by the invention in 1902 of his "Vacuum Augmentor," which was the prototype of the now universal steam jet air ejectors. Among his many improvements in electrical machinery perhaps the most spectacular was the construction in 1928 of the first of a number of large turbo-alternators to generate directly at the unprecedented pressure of 36,000V with the same factor of safety as the ordinary 11,000V machines. This was made possible by the use of his concentric conductors for the stator winding. Shortly afterwards he made a further advance by the use of non-metallic end shields, which, by reason of their lightness and non-magnetic properties, were a great improvement on the previous cast iron shields. Other exceptional electrical machines were a pair of high-speed motor generators, each capable of the enormous short-circuit output of 1,500,000kVA at either 6350V, 11,000V, 12,700V or 22,000V, as might be required for testing switchgear.

The greatness of Parsons's contributions to electrical generation and marine propulsion has tended to overshadow the benefits of his work to industry generally. Besides developing a variety of back-pressure, mixed-pressure and pass-out turbines, he also led the way in the construction of turbine-driven fans, blowers, compressors and pumps for mines, blast-furnaces, gasworks, waterworks and other undertakings. In 1891 he instituted the practice of overspeeding every wheel or disc used in his turbine machinery sufficiently to stretch its bore beyond the elastic limit before shrinking it on to the shaft, a procedure that completely eliminated the risk of wheels becoming loose in service. Furthermore, in order to ensure the soundness of the steel for his forgings, he devised a process in which the ingot, when cast, was allowed to solidify only from the bottom upwards, thereby precluding any possibility of "piping." Among other inventions of general application is his method of "creep-cutting" the teeth of gear wheels, which enables gearing to be produced with an accuracy previously impossible. His interests were so wide and his knowledge so extensive that his inventiveness found scope in directions far removed from ordinary engineering. He successfully developed the manufacture of electric arc and incandescent lamps in his younger days, and also devised a method of making parabolic mirrors for searchlights in 1886, which is used without appreciable change to-day. He was convinced of the practicability of mechanical flight long before most people, and in 1893, well in advance of the successful experiments of Langley in America, Parsons constructed a little helicopter, driven by an alcohol engine, which would raise itself vertically by its own power. He then converted it into a monoplane of 11ft span, in which form it would fly for 80 yards before its fuel supply was exhausted.

As will have been gathered from this brief reference to a few of his achievements, Parsons was a man of enormous energy and an indefatigable worker. His aim was ever to make progress, and it is safe to say that no previous engineer ever lived to see such enormous advances in industrial fields brought about by his own efforts. Great Britain has produced many world-famous engineers, and it may well be that future generations will consider the greatest of them all to have been Sir Charles Parsons.

# International Railway Congress, 1954*

(*Continued from page* 815, *June 4th*)

## No. III—RAILWAY WORKING

*At the London Congress the discussions of the section dealing with railway working were devoted to the remote operation of signalboxes, with particular reference to the system of coded remote control known as C.T.C.; to control devices for hinged and flexible points, and to questions of radiophonic communications in railway working.*

### Remote Control

BEFORE drawing up their reports, a questionnaire drafted by agreement of the three reporters concerned had been circulated to all administrations belonging to the Association. The questionnaire was most detailed and extensive, but as the subjects for discussion concerned, for the most part, some of the most advanced practice in railway operation, few of the administrations to whom the questionnaire was sent have had sufficient experience to send a reply. The eight railway systems that did reply, however, contributed to the making of an interesting report, which will doubtless be of value to those others who are at present contemplating some form of remote control. The combined experience with remote control of the European countries, including Great Britain, is at present small compared with that of the American railways; but while the wealth of technical experience gained in the U.S.A. is available for other administrations to study, the railway operating conditions here are in most cases so different, that careful individual studies must be made of each project as it arises.

The summaries emphasise the different ways in which remote control is being applied in various countries. It is in America that C.T.C. is being applied so successfully to the working of single lines. There it is being adopted in order to increase the capacity and flexibility of the working on busy routes in the hope of avoiding the need for doubling the line, and at the same time to effect a reduction in the number of staff on duty. During the second world war it was introduced on many long stretches of single-tracked railway in the West and Middle West of the U.S.A. These lines previously had no signalling at all, and C.T.C. provided a means of greatly increasing line capacity over that which was possible under the previous system of working with written train orders. Both the French and the Italian railways are much interested in C.T.C. at the present time, and it was emphasised in discussion that the greater benefits from C.T.C. on single lines are likely to be experienced where the working is by train order, rather than where points and signals are worked by the station staffs. But many of the great trunk routes in America carry very few trains, by Western European standards, and the discussion concerned more vital operating problems when it centred upon remote control in general, as a means of extending the sphere of action of individual signalboxes and control points.

As we mentioned in the second of these articles dealing with the possibilities of main line electrification in this country, the question of traffic regulation is an extremely important one. Hardly a week passes without our learning of serious delays to fast and important traffic through signalmen not knowing the precise whereabouts or speed of approach of oncoming trains. It has been clearly shown that the establishment of large central control points, such as York, greatly facilitates the task of the signalmen, and largely eliminates delays to through traffic arising from local conflicting movements being made where there is insufficient margin of time before an important passenger or freight train. It was suggested that C.T.C. might be applied to extend the area controlled from one signalbox. The saving in first cost depends upon the balance obtained between the reduction in the cost of cabling and that of providing the remote control equipment. Judging from the various replies summarised in the final report, this saving in first cost becomes more noticeable as the number of items of apparatus remotely controlled at each location increases, and as their distance from the central controlling apparatus becomes greater. While there are definite possibilities for economy in first cost, where C.T.C. is concerned the volume of traffic must also be considered, and we were not surprised to hear Mr. J. H. Fraser, Chief Officer, Signals and Telecommunications, of the British Transport Commission, emphasise this point in the discussion. There comes a time when the codes for remote control cannot be transmitted fast enough to deal with the traffic.

Several references were made to the use of C.T.C. on double tracks. In both France and Germany some notable installations have been put into commission in order to increase the capacity and flexibility of working and to avoid having to lay down the additional running lines that would otherwise have been necessary. On the former P.L.M. line in France advantage has been taken of the very marked variations in traffic density at different times of the day. Southbound traffic from Paris is heaviest during the night, when the procession of sleeping car expresses for Mediterranean, Swiss and Italian destinations has to be handled; and there is a correspondingly heavy period in the northbound direction. On the stretch of line between Blaisy-Bas and Dijon both running lines have been signalled for either-direction working; C.T.C. has been installed, and the section controller can thus use both lines for traffic in the same direction at heavy periods. All running movements are remote controlled, and by judicious use of the tracks freight trains and other traffic

* Held in London, May 19th to 26th.

can be kept moving at the same time as the long succession of faster trains are sent through. In Germany the installations of C.T.C. on double track have not so far included any instance of either-direction running. C.T.C. has been found worth while in order to increase the flexibility of working and give those responsible for regulation of the traffic the broadest possible picture. By this means, as at York, the incidence of traffic delays is much lessened.

The Regensburg–Nuremburg line was specially mentioned in the summary report prepared by Professor A. Dobmaier, of the German Federal Railways. This line is about 52 miles long, and its capacity amounts to 150 trains per day in both directions. It has the following operating features :—Three major stations (for which special control circuits are required) ; six remotely controlled smaller stations ; three stations with key interlocking ; four halts with protective signals ; one passing siding, one two-side block post and one one-sided block post. The most important of the remotely controlled stations comprises fourteen pairs of points and six signals. The total number of remotely controlled functions on this whole line amounts to seventy-four pairs of points and ninety signals. Generally, the German Federal Railways have found it most advantageous to install C.T.C. on lines carrying a heavy traffic with a large number of small stations, and only a limited number of larger centres at which operating staff are permanently on duty and where numerous shunting movements have to be carried out. The line between Nuremburg and Regensburg previously mentioned is a very good example, the entire 52 miles being controlled from C.T.C. machines installed at Nuremburg.

The possible use of C.T.C. to extend the area controlled by large and complex interlockings at major centres of traffic brought forth an unusually interesting discussion. Several delegates raised the question of the procedure to be adopted in case of failure of the C.T.C. apparatus. If considerable reduction of staff were effected some concern was expressed as to how quickly assistance could be obtained to put matters right. Delegates from the French National Railways said that incidents of this kind were so extremely rare that no special arrangements were in force. No emergency electrical apparatus was provided for ; manual operation on the site is alone employed. Another French delegate expressed his complete faith in C.T.C. apparatus. Somewhat naturally the views of Mr. F. G. Maxwell, Operating Manager (Railways), London Transport Executive, were far otherwise. The density of traffic on those lines was such that they could not possibly afford to place 100 per cent reliance on the apparatus. One had to consider the repercussions that could arise on railways carrying forty trains per hour in each direction, and in the remote control installations they had put into commission in recent years operating staff had been retained to act quickly in case of emergency. Arrangements for electrical working had been provided, as on lines of such traffic density one could not afford to await the arrival of the maintenance men.

At this point we may remark that so far as we know the system of remote control in use on the London Transport lines is unique. The outlying functions are operated from an interlocking frame, generally of normal design, but arranged for remote control. The levers, instead of being actuated by a signalman are pushed or pulled, as the case may be, by small compressed air cylinders. The operation is regulated by a coded remote control system. In the event of any failure of the remote control apparatus a signalman is sent to the outlying frame, and this is operated like a normal electro-pneumatic interlocking frame until the fault is remedied. So far as the remote control apparatus is concerned, the Congress noted that the numerous relays used are more similar in type to telephone type relays than to signalling relays, but an endeavour is made to improve their quality and characteristics by a finer degree of manufacture, using improved up-to-date processes and sometimes by making them larger and more robust than actual telephone relays.

The maintenance and upkeep of remote control installations do not appear to offer any special difficulties. Failures of the equipment itself are very few, thanks to the progress made in their design and construction. The tendency is to group relays together in suitable assemblies in dustproof cases with plug-in type connectors. This enables any assembly to be replaced by a spare one in a few seconds. The period of regular overhaul of equipment varies with the amount of work each group of apparatus is required to perform, according to the density of the traffic.

The second part of the general question on signalling matters concerned points operation, and a section of particular interest dealt with means to control the accidental trailing of the switch blade. With a pair of locked points as used on British Railways a trail-through on the wrong line can cause considerable damage, and result in delay until such time as when repairs have been carried out. Such damage and delay has been accepted as some of the consequences of a serious engineman's error, and this view has also been taken in France, the United States, India and New Zealand. In many European countries, however, including Belgium, Holland, Germany, Italy and Switzerland, apparatus has been provided to minimise the damage caused by an accidental trail-through. It is not that such an incident is condoned—which it is not—but that an attempt is made to minimise both damage to apparatus and delay to traffic. Features of the standard trailable apparatus used on the Continent of Europe are of interest and importance in Great Britain in view of the market for signalling apparatus existing overseas, no less from the many overseas railways with which British engineers are connected. Some details of the German electric trailable mechanism are given in the summary presented to the Congress.

The German switches which have a point lock, where the tongues are moved by an articulated bar (switches of normal design), function as follows : during the trailing operation of the switch the flange of the wheel first presses against the open tongue, which by its movement releases the point lock and then also moves the closed blade by means of the stretcher rod ; the driving rod acts on the transmission of the point machine and unlocks the retaining disc. This reverses the circuit control levers, blows the detection, the circuit fuses and de-energises the detection magnet ; in case of an all-relay signalbox this entails the energising of the trailing relay and the fact that the points have been trailed is indicated on the panel by means of a flashlight.

In the case of an all-relay signalbox, should a switch become trailed, the line representing the track on the control panel is illuminated in red in the direction from which the switch was trailed. Each trailing movement is registered by a counting device. The apparatus indicating the trailing holds all route levers until the trailed switch has been returned to its normal position. The tongues remain in their respective positions after having been trailed, but it should be mentioned that in most cases the point lock does not attain its final position.

Generally it can be stated that opinions are divided on the question of using trailable devices to prevent damage to the points themselves or to their electro-mechanical operating mechanism. Some administrations limit their use to marshalling yard tracks and certain subsidiary ones. On the other hand, others make use of the trailability feature for electrically operated points as a general practice on main running lines, save, sometimes, in the case of points with flexible tongues.

Some administrations follow a kind of middle course in this matter. On main running lines they give preference to the non-trailable point machines, on condition that there is a proper arrangement of fixed signals to protect the points which require to be taken from the trailing direction. Where such signalling is not provided then trailable equipment is adopted. This reduces to the minimum interruptions to the traffic and does not require the presence of special staff to make good any damage, such as results from trailing through points in the wrong direction. It is the usual practice to indicate in the signalbox when a pair of points become trailed through, whether they are actually of the trailable type or not, by means of a visual indicator, often supplemented by an audible indication.

### Radiophonic Communications

The special report of Mr. S. G. Hearn, Operating Superintendent, London Midland Region, British Railways, on this subject is historic, in that it is the first time at a Congress session that radiophonic communications in railway working has been discussed. For several aspects, indeed, the use of radio has passed beyond the experimental stage, and in some countries, particularly the U.S.A., it has been widely adopted in regular day-to-day operations as a permanent feature. Mr. Hearn described methods of establishing communications with, and on trains *en route*, which are more particularly suitable for North American operating conditions, but his findings with regard to marshalling yards and terminal areas appear to have considerable application in this country.

The efficiency and speed of working in a marshalling yard is largely dependent upon the character of the appliances provided to transmit and receive instructions. Radiotelephony is already extensively employed and is being introduced on a growing scale, particularly in the U.S.A., and to a lesser extent in some European countries, as a supplementary aid to establish communication with drivers of locomotives or individuals whose duties require them to be mobile. Such communications can lead to savings in locomotive and man-hours, reduction in the number and gravity of mishaps, and a speed-up in shunting operations and the clearance of sorting sidings.

The introduction of radio in marshalling yards is simplified by there being few, if any, transmission difficulties because of the limited distances involved. The method of application most widely adopted is between a fixed point and locomotives engaged on shunting operations, especially for regulating the speed of propulsion over a hump or in a flat yard.

In Great Britain there are some yards where certain instructions are conveyed to drivers of shunting locomotives by means of a simple code of audible signals given by electric bells, klaxon horns or mechanical

gongs, located in the open alongside the shunting line and operated from a distance by a button, plunger or lever. In some instances this method is in force regularly, but in others it is only brought into use during fog or falling snow. Hitherto this method of transmitting audible signals in connection with shunting movements has met requirements, but with the growth in the number of diesel-electric shunting locomotives a difficulty has come to light recently in that drivers cannot rely upon hearing the signals owing to the humming noise inherent in that class of locomotive and due to the more enclosed character of the cab compared with that of a steam engine. Investigations are in progress as to alternative means of overcoming the difficulty, including the possible application of radio ; but the latter envisages either the equipping of the locomotives with aerials, suitable electrical connections and the necessary radiophonic apparatus, or the development of a suitable and readily portable complete outfit. Locomotives have necessarily to be changed at times for fuelling and maintenance purposes, and there are also occasions when a steam locomotive may have to be utilised at short notice for shunting. Then it would seem that a portable outfit is essential.

In the environs of large cities and towns there are usually several traffic yards and depots, as well as siding-connected factories, between which transfers of loaded and empty wagons are necessary, and locomotives, guards, and shunters have perforce to perform shunting operations at some distance from their base. Similar conditions exist in extensive dock and harbour areas. It is customary to lay down scheduled workings for the trip engines so far as this is practicable, but variations inevitably arise in the volume of traffic to be dealt with from day to day, and urgent requirements have to be catered for. A considerable amount of waste movement and time can be avoided and greater efficiency attained by employing radio between a central supervisory point and the locomotive. It is a matter for consideration whether this system could be applied with advantage in areas where there is intensive trip working ; for example, in districts where there are many collieries.

Marshalling yards, terminal areas, and collieries are all possible points of congestion on the crowded tracks of British Railways, and it is most interesting to observe the advantages of radiophonic communications brought out so clearly in the proceedings of this Congress.

(*To be continued*)

# High-Speed Wind Tunnel at Hatfield

*The extensive nature of pre-flight aerodynamic testing dictated by the characteristics of modern high-speed aircraft has made imperative the provision by leading aircraft manufacturers of their own wind tunnels to relieve the load on existing installations largely concentrated at Farnborough and Teddington. Details are given of the 0·8–1·6 Mach number induction tunnel turbo-jet driven, which, together with a low-speed closed circuit tunnel, have been recently commissioned by the de Havilland Aircraft Company, Ltd., Hatfield.*

AT the Hatfield works of the de Havilland Aircraft Company, Ltd., last Thursday, two new wind tunnels were officially opened, the construction of which began less than a year ago. One of these is a closed circuit wind tunnel of conventional design for speeds up to 170 m.p.h. It has a working section 9ft wide by 7ft high and employs a 12ft diameter fan driven by a 500 h.p. d.c. electric motor. The high-speed tunnel, which is described here, has a working section 2ft square and is designed for tests at Mach numbers between 0·8 and 1·6.

It is based on the straight-through induction layout, using three de Havilland "Ghost" turbo-jet engines as the source of inducing flow. This kind of installation has several advantages in this speed and size range, where only intermittent working is envisaged, and totalling less than about 200 hours per year. In this event the cheapness of its initial cost easily outweighs the much higher fuel and maintenance costs of the gas turbines. It also takes much less time to construct and to obtain the large electrical motors of equivalent output required for the alternative wind tunnel arrangements. There are several advantages also in being independent of the electrical supply. In this particular case not only was the tunnel most urgently required, but it is powered by engines made by the engine division of the company and the engines now installed were actually those of the prototype "Comet" aircraft. These are run at their maximum continuous cruising conditions when the combined thrust is 15,000 lb and the fuel consumption over 15,000 lb/hr. By ducting some of the effluent to the intakes upstream it is possible to adjust the humidity of the air to prevent clouding in the tunnel, thereby avoiding the expense of drying the air.

The ducting is arranged in two parallel limbs in a U configuration, the inducing effluent from the gas turbines joining the circuit at the U bend farthest downstream (Fig. 4).

*Working Section.*—The working section is of a fabricated construction, 20ft 6in long, the main centre tower being manufactured from 2in, 1½in and 1in thick plate, complete with two side doors set up on hinges. In machining these it was essential that no drop on the doors took place, and to overcome this ball thrust races were fitted. The sting gear by which the model is located is mounted on top from a pressurised casing through the centre of this tower, and the bottom section of the tower is made to take off the necessary tubes and wires for recording the reaction on the model when the tunnel is working. The machining of the inside faces had to be parallel and ground to a tolerance of plus and minus 0·0005in. Front and back faces are cut through to allow the lifting gear to be fitted for holding the top liner in place. In doing this, provision had to be made to seal the slots to stop any leaks from outside atmosphere getting through into the tunnel.

The four side panels, each weighing several tons, are of fabricated design and are made from 1½in thick plate, ribbed with tee section to withstand the suction in the tunnel, there being in this section a pressure differential of about 12 lb per square inch. These liners were planed and surface ground and covered with "Araldite." The four side joint faces have machined grooves to take special Dunlop inflated joints. These side panels are bolted to the top and bottom beams with special swing bolts to allow for quick removal when changing liners. Two of these side panels are fitted with special optical lenses for viewing the model and for photographic purposes.

The top and bottom beams are box section, fabricated from 2½in and 1in thick plate. Again, the machining of joints, &c., was held to plus and minus 0·0005in. Through the depth of these beams slots were formed to allow fitting of the main lifting screws which carry the liners. To seal these screws from the atmosphere plates were machined and ground, on to which were fitted special cast iron spherical block nuts, all hand scraped to 0·0005in. These blocks are fitted with brackets which carry the worm screw-down gear for operating the screws. The beams are bolted to the centre tower and are carried at each end by the two end towers, which again are made from 1½in and 1in thick plate.

*Adjustable Liners.*—It will be noted from Figs. 1 and 2 that the working section is arranged to use six aluminium liners per set-up. The two centre liners are used in all tests, but the four outside liners are made in three shapes, those shown having the simplest profile for the subsonic range. By making the liners adjustable while the tunnel is operating it is possible for all practical purposes to extend the range of each set and so cover most speeds in the design range.

The machining of these liners had to be of the highest standard and the contour planing was done on a 7ft "Butler" planing machine, using special contour bars. After machining, all liner windswept faces had to be hand scraped to give the necessary finish, and these faces were also sprayed with "Araldite." The "Araldite" coating prevents corrosion of the surfaces.

Felt rubbing strips are let into each side of

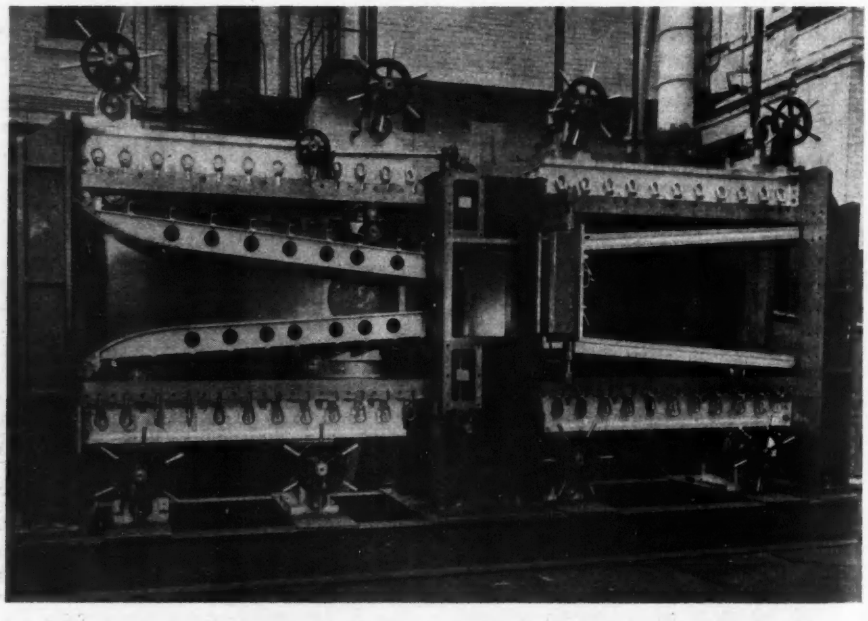


**Fig. 1—Rigid construction of the working section is apparent in this view in which two outer panels have been removed, revealing the method of liner location**

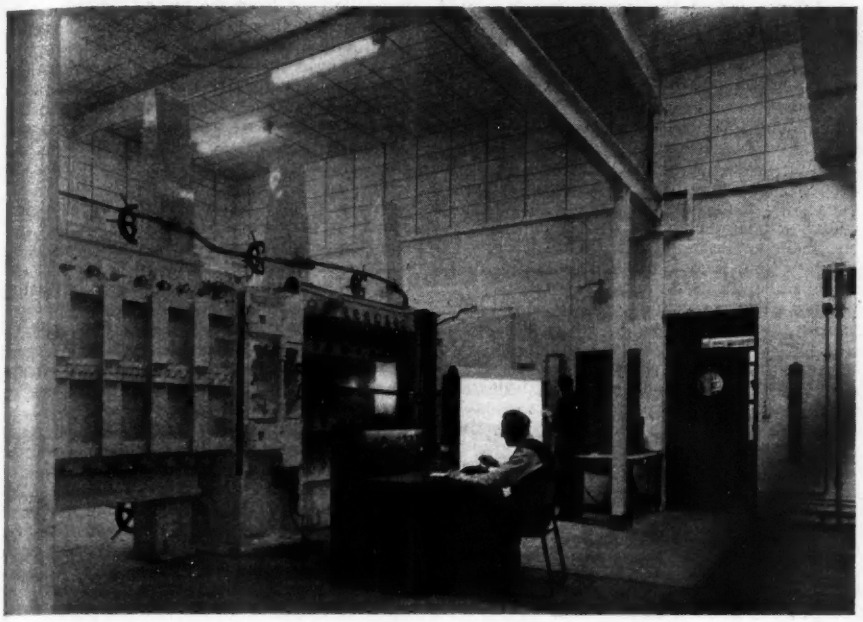


Fig. 2—The working section seen from the other side as installed in the control room. In the foreground is the "Ghost" engine control station and behind is one of the manometer tube stations

these liners to form air seals and to protect the side walls when the liners are moved up and down. Provision is made on each downstream liner to take up end movement by using special spherical bolts and ratchet. In the design of this section provision has been made for increasing the size of the working section and special packing liners are fitted to enable this increase in size to be undertaken as and when required.

The need for the precision and rigidity inherent in the design of this section can be realised from the fact that under the full differential pressure deflections greater than three to five thousandths of an inch can exert a critical influence on the flow pattern and had to be avoided.

The urgency with which this tunnel was required was one of the main factors in its design, and it is notable that only ten months elapsed between the design and delivery of this section. It was designed and made by Foster, Yates and Thom, Ltd., Blackburn.

Complete aircraft models will be mostly used in the tunnel and will be of steel construction to withstand the high loads. The "sting" on which the model is secured is attached to a vertical strut in the centre tower. Vertical movement of the strut determines the pitch of the model and bank is obtained by rotation of the sting core. The motors associated with these operations are mounted in a pressurised casing above the strut on the centre tower, and are remotely controlled. The loads and moments on the model are measured by electrical strain gauges housed in the sting within the model fuselage, and are read in conjunction with Elliot self-balancing potentiometers.

The ductwork of the tunnel was undertaken by G. A. Harvey and Co. (London), Ltd., London, S.E.7. It extends on both sides of the working section forming a U-shaped circuit, one end being the air entry, the other end the exhaust, with a hot air return duct spanning these open ends, for the purpose of by-passing and mixing hot dry air with the cold air intake. Each leg is approximately 100ft long by 35ft between.

Starting at the air entry end of the tunnel "hairpin"—to which splitters are fitted for mixing the cold air entry and the hot air return—there is an air settling chamber with stainless steel wire mesh filters, and a contraction cone with a carefully calculated reduction curve connecting to the working section. The size of the air settling chamber is 105in square. Downstream is the first diffuser, developing in size from 30in by 42in to 48in by 72in and then to 27⅛in by 79 $\frac{9}{16}$in, where the jet inlets are located. From this point extends the mixing chamber in the form of a rectangular to round transition piece of constant area; then the final diffuser opening out to 104 $\frac{11}{16}$in diameter. The exhaust leg finally terminates in a separator section, exhaust baffles and silencers, the separator section having an internal "aerofoil" for deflecting a predetermined amount of hot dry air to the air entry leg through the interconnecting duct.

Differential pressures with the external atmosphere occur at all parts of the circuit equivalent to 0·3 lb per square inch at the settling chamber, and 6·5 lb per square inch near the jet inlets. The specified working temperature of the tunnel was given as 100 deg. Cent. with a rise to 500 deg. Cent. forward of the jet inlets, and extending the length of the exhaust leg. To minimise the effect of noise emission the de Havilland Company decided to utilise one of its existing concrete test tunnels to house the jet engines and the exhaust leg. Consequently, the centre line of this leg was placed 14ft 6in above floor level, and supporting steelwork had to be supplied for carrying the ductwork at this level.

In the design of the ductwork perhaps the most exacting requirement, the manufacturers state—apart from meeting the stipulated shapes and contours to meet the aerodynamic requirements—was the thermal conditions of working with an expected temperature of 500 deg. Cent. in the exhaust leg. The calculated longitudinal expansion amounted to approximately 6in from the anchor support adjacent to the jet inlets, which was necessary to resist the engine thrust of 15,000 lb and the vibration set up. This expansion was intended to be taken up by an expansion joint situated between the final diffuser and the aerofoil section. As the diameter of the duct at this point was approximately 8ft 9in, there was also quite an appreciable amount of peripheral expansion to be considered. This expansion joint took the form of a sliding gland packed joint, the sliding surfaces running on a machined split cast iron ring to ensure freedom from binding or scoring, and was designed to minimise any break in the internal contour of the tunnel.

To cater for the high amount of expansion movement, and also the movement in the other parts of the tunnel due to the thermal condition, roller and trunnion arm supports were arranged as considered necessary between essential points of anchorage. In the high-temperature section the supports were designed to maintain a true centre line position for the tunnel not affected by diametrical or peripheral expansion. Rubber pads were interposed in many of the supports to minimise vibration.

For the hot section it was ultimately decided to use a high silicon boiler quality steel to B.S. 1501–154, recommended for service at temperatures exceeding 370 deg. Cent. This is a weldable

Fig. 3—Constructional details of side panel fitted with an optical glass window frame

Fig. 4—The engine arrangement chosen for ease of maintenance. This view shows the cross limb and exhaust trunk downwind of the installation

steel which was well known to the fabricators. The ductwork throughout was of fabricated electrically welded construction; the plate thicknesses ranged from $\frac{3}{16}$in to $\frac{1}{2}$in. Some of the ductwork, being square or rectangular in cross section, required panel stiffeners for strengthening the flat plate areas for the pressure requirements, and to avoid as far as possible the drumming caused by the jets when working at their full capacity of 10,250 r.p.m. This latter was entirely a matter of conjecture as there was very little experience indeed to guide the designers on this point the only known similar kind of tunnel being one which had recently been completed by the fabricators, and which, although working at lower temperatures, was fortunately started up during the design stages of the high-speed tunnel.

An endeavour was made to make the tunnel as flexible as possible, whilst retaining stability so as to avoid the ill-effects on such a structure of too great rigidity without freedom for flexing. The desirable method of stiffening, particularly in the hot zone, for the pressure conditions, and at the support points, would have been stiffeners which offered no restriction to thermal expansion. This was found to be impossible, but wherever practicable stiffeners were used of uniform thickness to the ductwork shell, with the maximum area in contact with, and in close proximity to, the shell, to avoid relatively cold areas giving uneven expansion.

In the actual fabrication use was made of modern methods of fabrication, including profile cutting and flame planing. Due to the variety of shapes manual welding was considered preferable to machine welding, but manipulators and rotators were used in the fabricating shops to facilitate handling and manufacture.

After erection and lining up the flanged joints were seal welded internally. It can be said that this ductwork illustrates the craftsmanship of the template maker and plater.

Streamlined flow was expected throughout the circuit, the angle of divergence in some sections being as low as 1 in 20. To meet these requirements all internal welds were ground smooth and faired off as necessary.

# Irreversible Gears with Trapezoidal Teeth and Parallel Shafts

WE learn from S. E. Opperman, Ltd., of Stuart Works, Stirling Corner, Boreham Wood, Herts, that it has secured the world-wide manufacturing rights of the "Sira" gear tooth-form and associated gear reducing mechanisms, such as that shown in Fig. 1. The history of this development in gear tooth design dates to 1946, when the S.I.R.A. Society was founded, being a technical and commercial society for the purpose of developing and marketing the gear principles on which Mr. Roano of Naples had been working for more than thirty years. He demonstrated at that time that it was both theoretically and practically possible to build an irreversible or non-reciprocating gear, consisting of two wheels with parallel axes and having an efficiency greatly superior to the only irreversible gear now in use, namely, the worm and worm wheel with axes at right angles to one another. He has also demonstrated the practical construction of reversible gears with high efficiency which allow very high transmission ratios never reached before with only two wheels and occupying very little space.

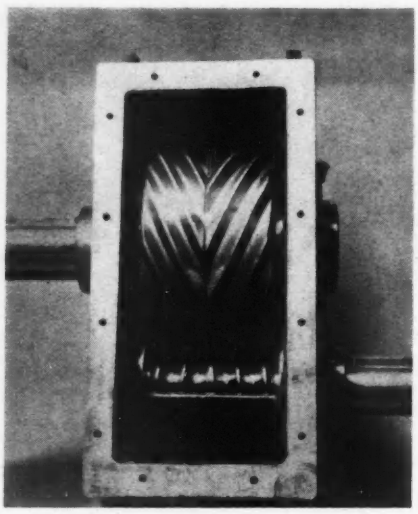


Fig. 1—Representative gear showing double helical tooth form and shaft arrangement

At the request of the S.I.R.A. Society of Genoa, in 1951, some efficiency tests of one of the small irreversible gears were carried out under the direction of the University of Genoa and Politecnico di Milano. The gear comprised two parallel shafts on which were mounted two wheels with double-helical teeth of a special trapezoidal shape, the helix angle and, therefore, the circular pitch, of the teeth on the pinion being different from those of the teeth on the larger wheel, so as to allow, as a result, a transmission ratio different from, and greater than, the corresponding ratio between the diameters of the pitch circles of the same two wheels. There is always a plurality of teeth meshing at the same time.

The distance corresponding to the pitch diameter of usual wheels—a dimension which in the present case cannot properly be referred to as the "pitch diameters"—was respectively 42mm for the pinion and 128 for the wheel. Because of the particular shape of the teeth and the particular inclination of the helices, the expected transmission ratio, according to the test report, was fully verified to be 1 : 11. As well as demonstrating its irreversibility and consequent automatic stopping on failure of the drive and continuation of the opposing torque, efficiency values above the limit of 0·5, generally considered the highest for irreversible gears, were achieved (Figs. 2 and 3). The report also found that the efficiency tended to improve as the power increased, but remained substantially constant for the value of 1·2 h.p. It concluded by saying that no overheating of the reducer was noticed and it was observed that the temperature of the lubricating oil stabilised after long operating at 25 deg. above the room temperature.

The shape of the tooth section, cut perpendicularly to the helices, is fully trapezoidal and relatively thick at the base, thus giving the teeth, it is claimed, a resistance to bending and breaking strains far higher than that of existing tooth forms.

The contact of the teeth is on a line which, in the case of the reversible gears, is not the line jointing the centres, but displaced from the plane of the axis by a distance varying according to the desired degree of irreversibility. It is claimed by S.I.R.A. that the mechanical efficiency of the irreversible gears is as high as about 0·72, and is thus far higher than that of the worm and worm-wheel gear, which, it is stated, when positively irreversible, never has an efficiency greater than 0·4, and it maintains that the parallel position of the axes permits more compact constructions. They do not present limiting restrictions with regard to the reducing ratio, as it is possible to construct irreversible toothed gears having a reduction ratio even of 1 : 2 and 1 : 1.

*Reversible Gears with Reduced Diameters.*—In reversible gears with a driving wheel of a given size and for a given speed ratio, the diameter of the driven wheel is much less than it would be under the known module system. The performance of a typical gear is recorded in Fig. 3. This reduction gear has a 1 : 40 ratio, comprising only two wheels transmitting 20 h.p. at 2000 r.p.m. The driven wheel has a pitch diameter of 725mm, whereas under the module system the diameter would be about 3·2mm. The very high reduction ratio obtained with a single couple permits a considerable reduction in space, weight and cost of the assembly.

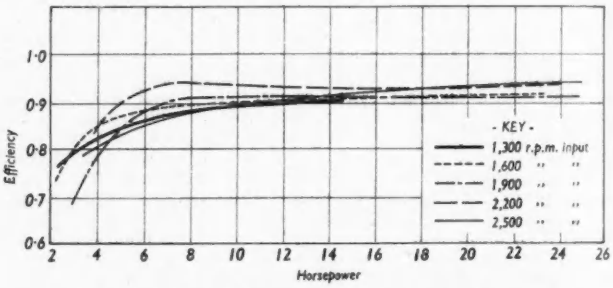



Fig. 3—Performance of "Roano" reversible gear with trapezoidal teeth and a reduction ratio of 1:40

It is explained that this is largely due to the contact surface for each meshing tooth being much larger than in any other known gears. The shape of the teeth, sectioned with a plane perpendicular to the helices is concave for the wheel and convex for the pinion and the contact surface, like the contact lines of the irreversible gears, is displaced with respect to the line connecting the axes.

The performance of these gears, the Society maintains, does not depend to any great extent on the materials used.

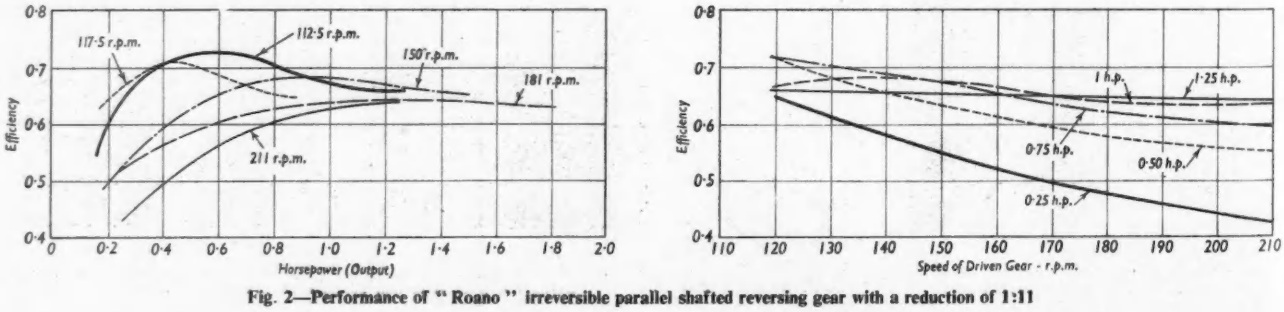



Fig. 2—Performance of "Roano" irreversible parallel shafted reversing gear with a reduction of 1:11

# Aluminium Mill at Falkirk

No. II—(*Concluded from page 828, June 4th*)

*The light alloy rolling mills which were constructed at Falkirk to produce material for military purposes were acquired by the British Aluminium Company, Ltd., after the war and since then have been modified and adapted to meet the post-war market requirements. The work of conversion has gone forward in two stages, first the adaptation of existing plant and, secondly, the construction of new buildings to house additional processing plant to increase the capacity of the mill.*

### Cold Rolling Line

At the west end of the hot lines are five cold strip mills all supplied by W. H. A. Robertson and Co., Ltd., and equipped with drives by the English Electric Company, Ltd. Mills Nos. 1, 2, 3 and 4 are all in line in one bay and mill No. 5 in the adjoining bay. No. 1 mill is a two-stand, four-high, tandem roughing mill 17in and 42in by 61in, each stand being equipped with a 1000 h.p. drive with constant torque up to a rolling speed of 148ft per minute and constant horsepower to 295ft per minute. Hot rolled blank 0·25in thick by 4ft 6in wide is given its first stage cold rolling and the mill has a pay-off coil box, a pneumatic nine-roll entry bridle, a pneumatically operated looping roller controlling the strip inter-stand and a flying micrometer on the outgoing side. An edge trimmer with scrap cutter is positioned between the outgoing roll stand and the coiling drum, which is a 26in by 60in, three segment collapsing drum complete with hydraulic coil jack and pneumatic ejector. There is an up-coiler for dealing with material thicker than that which can be taken on the tension coiler. A drum pattern tail puller tails the coils, standing on a cradle bogie, in advance of the decoil box and thus assists threading through the entry bridle and into the roll bite. The work rolls are of solid forged alloy steel having a Shore "C" hardness of 90/100 deg., while the back-up rolls are of forged steel composite construction and cooling is by flood lubrication using a low viscosity mineral oil.

The mill motors of 0/1000/1000 h.p. r.m.s. at 0/400/800 r.p.m. are fed by a generator set consisting of a 2200 h.p., 6·6kV salient pole synchronous motor and five d.c. machines. There are two 700kW generators and the drum coiler has a 225 h.p. drive with automatic compensation for inertia and coil build-up to give a maximum forward tension of 26,000 lb.

No. 2 strip mill, which is engaged on intermediate/finishing duty, is practically identical with No. 1 mill except that the maximum rolling speed is 480ft per minute on the second stand and there is no roll coiler on the outgoing side. Nos. 3 and 4 units are single-stand, two-high, strip finishing mills, each having a drive of 0/600/600 h.p. r.m.s., with a corresponding rolling speed of 0/240/420ft per minute, and solid forged steel rolls carried in Robertson "Flood" bearings. Each mill has a travelling jack wagon which raises the reel between the expanding cones of a twin reel decoiler, and a seven-roll fully-tucking entry bridle having powered sticker action on the entry side, and on the outgoing side a pair of twin head expanding cantilever drums equipped with a belt wrapper while a flying micrometer provides for continuous gauging. A d.c. motor of 0/600/600 h.p., r.m.s., at 0/800/1400 r.p.m. drives each mill and is supplied by a motor generator set driven by an 850 h.p., 6·6kV a.c. synchronous motor coupled to a 600kW generator. Each coiler is driven by a 225 h.p. motor.

Each stand of No. 5 mill, which is a 20in and 49in by 84in two-stand, four-high unit, is driven by a 0/1500/1500 h.p. r.m.s. motor at rolling speeds of 0/300/450ft per minute and is fitted with Robertson "Flood" bearings. The solid forged alloy steel work rolls of 95/100 deg. Shore "C" hardness, have a working face of 84in, while the back-up rolls are of cast or solid forged steel. All stages of cold rolling on material of 4ft and 6ft finished width are carried out by the mill, which is capable of paying off hot rolled blank at 0·25in thick and cold rolling, with intermediate anneals, down to finished gauge. To do this the mill is equipped with a drum pattern tailing machine from which the tailed coils are moved by a carriage to the pay-off coil box, the strip then entering the first stand through a nine-roll pneumatic tucking bridle having rolls of 6in diameter by 84in face width. A pneumatic tension roller operates on the strip inter-stand, and on the outgoing side of the second stand there are a continuous gauging station, an edge trimmer and scrap cutter and 30in by 84in, three segment coiler drum with an up-coiler as an alternative. Controlled drum tensions up to 40,000 lb are available.

A motor of 0/1500/1500 h.p. r.m.s. at 0/400/600 r.p.m. powers each stand and the drum coiler is powered by a motor of 0/550/550 h.p., r.m.s., at 0/480/900 r.p.m., while the roll coiler has a 150 h.p. drive. These motors are supplied from a Ward Leonard motor generator set consisting of a 6·6kV motor of 3500 h.p. at 1000 r.p.m., with excitation arranged for unity power factor at full load, which drives two 1100kW generators, a 182kW drum coiler booster, and a synchronous motor exciter. In common with the other strip mills, cooling and lubrication are by the flood application of mineral oil through pressure sprays, on the ingoing side of each stand, mounted above and below the pass line. Each mill has its own oil storage and circulation system, strainers and circulating pumps, while the catchment system prevents contamination by other lubricants and so permits recirculation of the oil. Multi-tube heat exchangers, using canal water as a medium, control the coolant temperature, while the oil fumes are removed through hoods and ducting by induced draught fans. On all the mills the fire precautions, due to the presence of large quantities of rolling oil of low flash point, include a Walter Kidde built-in $CO_2$ fire-fighting system with "rate of rise" temperature detectors.

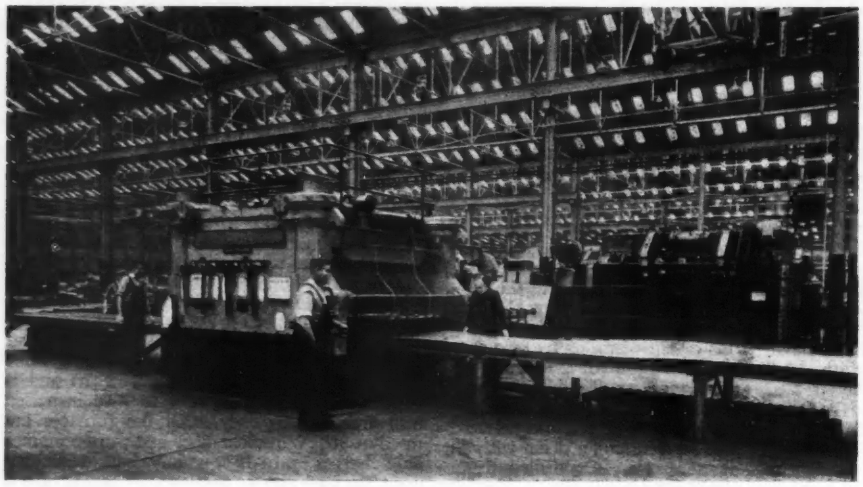
### Annealing and Heat-Treatment

As required between successive reductions, the coils are annealed, and in Block "C" are two Priest producer gas-fired tunnel furnaces. The coils, up-ended on bogies, are moved by hydraulic pushers through the various furnace zones, which are separated by power-operated doors. There is a preheating zone, 24ft long, a 24ft long soaking zone, and a cooling zone 65ft in length, and the furnace plant, which operates at annealing temperatures up to 450 deg. Cent., will accommodate coils 80in wide and 42in maximum outside diameter. For loading into the furnace the coils are delivered by fork-lift truck and laid horizontally on a power-operated up-ender loaded with an empty furnace bogie. Operation of the up-ender loads the bogie, which passes through the furnace to return to the up-ender, where the motion is reversed for the removal of the annealed coils. Four double-chamber electric box furnaces, supplied by the General Electric Company, Ltd., and G.W.B. Furnaces, Ltd., are installed in Block "D," which has a span of 80ft and is 350ft long. Three have a chamber height of 5ft and slow-speed air agitation, while the fourth has a chamber height of 7ft and is fitted with recirculating fans to give increased heat transfer efficiency. All the furnaces are rated at 360kW per chamber and can accommodate charges up to 10 tons in weight, depending upon the make-up of the load. There is also a G.E.C. 300kW, single-chamber, double-ended, reversible conveyor pattern furnace with a chamber height of 5ft and a length of 36ft. Two Gibbons Van-Marle 10-ton multi-arm charging machines serve the furnace units and the coils are deposited by fork-lift truck on a three-coil motor-operated tippler machine, which loads them on to a bogie end on. The loaded bogie is moved through the furnace by electric pushers and extracted by a pneumatic ram for return to the tippler for unloading.

The intermediate trimming and recoiling lines, capable of edge trimming or splitting coiled strip of 0·125in maximum thickness and up to 54in wide, are located in Bay "E." This intermediate trimming operation ensures the removal of bad strip edges before the material goes forward for further cold rolling. There are two lines, one to handle material 54in wide up to 450ft per minute, and the other, which has a speed of 800ft per minute, is to be modified by the addition of an 84in coiling drum, to process strip up to 78in wide. To control the spring-back of the thick hard-rolled coil there is a hydraulic pay-off roller, which bears on the outer laps and feeds the strip forward during threading operations.

Near No. 4 and No. 5 cold mills are two levelling and flying shear lines, one manufactured by the Hallden Company, of America, and the other by W. H. A. Robertson and Co., Ltd., to Hallden design. These units can flatten and shear coil into sheets having a finished width of 76in. and ranging in length from 2ft 6in to 20ft and in thickness from 0·015in into 0·150in, at speeds from 100ft to 300ft per minute. The

**Sheets being fed into a "Stamco" resquaring unit. In the background is a similar machine showing the side cut shears and the end cut shears**



8in by 100in heavy plate leveller forming part of the thick plate finishing plant

sheets emerge from the machines over belt conveyors to stacking frames.

For the heat-treatment of the strong alloys there are five lines of electric salt bath furnaces of Birlec-Kaercher design, and associated quench and wash tanks and drying ovens in Block "F." Four of the lines have furnaces rated at 330kW and capable of solution treating sheets 42ft long by 4ft wide, while the fifth bath can take sheets measuring 18ft by 6ft and is rated at 600kW. There is also a Priest single-chamber producer gas-fired high-speed air circulation furnace embodying vertical quenching in a mobile quench tank, into which the charge is lowered through the horizontal sliding doors forming the furnace hearth. The charge hoisting gear is detached and the tank moved from beneath the furnace and then the charge is removed and dried in an air oven. For low-temperature precipitation there is a Priest single-chamber, producer gas-fired air circulation furnace capable of accommodating flat sheets 76in wide and 25ft long, each charge being made up in tiers of shallow packs. Loading is by an electric charging machine and the charge is cooled in a chamber having rapid directional air flow.

In the same bay as the heat-treatment plant is a process line for carrying out "Alocrom" chemical treatment. Here sheet or plate material up to 14ft long by 4ft wide is degreased, rinsed, given "Alocrom" treatment at about 115 deg. Fah., rinsed, given a deoxylite dip and finally dried in a recirculated hot air oven.

A line of sheet rolling mills is placed in Block "G" and consists of two-stand trains of two-high mills of the following sizes :—24in by 72in, 28in by 72in, 28in by 84in and 32in by 84in, with drives ranging from 100 h.p. to 300 h.p. per train. A 10-ton gantry is available for roll changing. Roller levelling, stretching and shearing to size are carried out in the finishing department, one bay being equipped for heavy-gauge sheet and light plates up to 6ft wide by 18ft long by $\frac{3}{4}$in thick, while the other bays deal with sheets up to 6ft wide by 16ft long in thicknesses ranging from 0·018in to 0·125in. There are eight roller levellers, the hydraulic stretchers range from 150 tons to 400 tons capacity, and shearing is carried out on three "Stamco" resquaring units, which are served by conveyors. These units consist of two ganged, 17ft side cut shears, which can cut sheets up to 6ft in width, and two ganged end cut shears which can deal with sheets up to 16ft in length. Two machines were supplied by the Streine Tool and Manufacturing Company, and the third was built by Head, Wrightson Machine Tools, Ltd., to Streine designs. For dealing with heavy sheet or plate there is an 18ft by $\frac{3}{4}$in Loewy shear, while for finishing thick plate there are, in Bay "P," a Head, Wrightson leveller, two Wickman milling machines for machining plate edges, and a Loewy shear capable of single cuts up to 7ft 6in or nibbling cuts on plate up to 1in thick. The building housing the heat-treatment plant and finished sections consists of five bays, one of 32ft span and four of 70ft span, all having a length of 575ft.

### Stage II Development

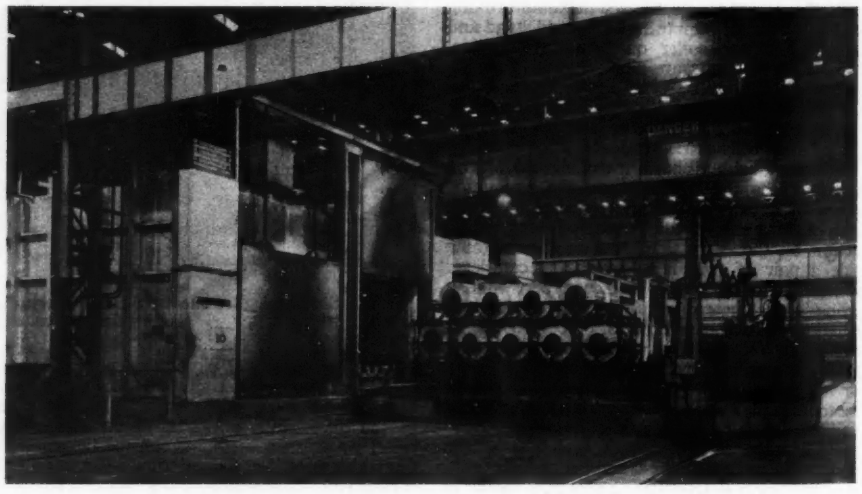
Stage II development, which lies north of the line *X*, *Y*, on the plan (page 826 *ante*), centres around a three-stand, four-high tandem mill and a single-stand, four-high temper mill. The buildings are generally constructed of steel framing covered with corrugated aluminium sheeting and lined with soft insulation boarding. The main block consists of two bays, each of 100ft span, separated by a 40ft transport bay, and the south bay is served by a 65 tons, 100ft span crane, while 5-ton cranes serve the north bay. An 80ft bay links the new bays with the parent mill and adjoining the north-west corner of the remelt shop is a single-span aluminium alloy structure, measuring 110ft by 125ft, to house additional block reheating plant. The bulk coil transport system, based upon the use of the 15-ton capacity multi-arm Wellman Smith Owen turntable charging machines, largely determined the layout and disposition of the plant at this development stage, and our illustrations show some of the process units.

At the western end of the block is the annealing plant, supplied by G.W.B. Furnaces, Ltd., and McDonald Furnaces, Ltd., consisting of two double-chamber, batch pattern, high-speed air-circulation electric furnaces, each equipped with two forced cooling chambers. These can reduce the charge from 450 deg. to 100 deg. Cent. within the furnace cycle time of between six to eight hours. One furnace, rated at 450kW per chamber, has heating chambers 18ft long by 9ft wide, accommodating up-ended coils 54in wide, while the second furnace, which has the same hearth size, has a 550kW rating per chamber and will take coiled strip 78in in width.

Both of the additional cold strip mills were built by Davy United Engineering Company, Ltd., and the electrical equipment was supplied by the English Electric Company, Ltd. The 15in and 38in by 44in three-stand, four-high mill (No. 6) takes stock ranging from 15in to 38in wide and from 0·036in to 0·12in thick, while the outgoing strip ranges from 0·008in to 0·048in thick. Stock is delivered by the multi-arm transport to loading tables and forwarded to the mill by a conveyor system supplied by W. and C. Pantin, Ltd. Each coil is placed on a coil down-ender from which it proceeds via a gravity vee track conveyor to a coil carriage and then to a tailing station. The tail enters a roller leveller and the coil end is trimmed and squared in an up-cut shear before the coil joins the other tailed coils on a slat conveyor ready for charging into the pay-off stand by means of a hydraulic jack carriage. Stock is paid off from a cone decoiler integral with an eleven-roll, hydraulically operated entry bridle and there are also entry bridles to the second and third stands. Outgoing strip having a maximum speed of 850ft per minute, is coiled on a wedge-operated reel fitted with a belt wrapper and strip tensiometers are provided between the stands capable of measuring strip tensions up to 20,000 lb to within ±2 per cent.

Each stand is driven by a d.c. motor having a r.m.s. rating of 0/500/500 h.p. at 0/410/920 r.p.m., supplied from a Ward Leonard motor generator set driven by an 1800 h.p. slipring induction motor with two 625kW d.c. generators. The motors drive through graded reduction gears to give the following rolling speeds :—No. 1 stand, 232/519ft per minute ; No. 2 stand, 306/687ft per minute, and No. 3 stand, 355/795ft per minute. The solid forged alloy steel work rolls are of 95/100 deg. Shore "C" hardness, and operate in Timken roller bearings, while the cast steel back-up rolls are carried in "Morgoil" bearings.

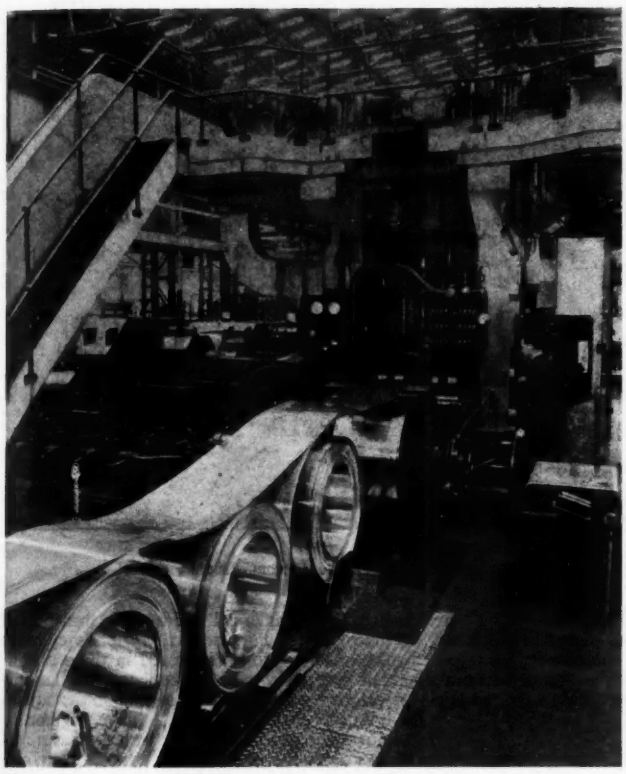
The single-stand 15in and 38in by 44in, four-high temper mill (No. 7) is similar to the third stand of No. 6 mill and is powered by a 500kW Ward Leonard set driven by a 756 h.p. slipring induction motor. Both mills have a common rolling oil system, the equipment being accommodated in a "coolant" house. Circulating pumps having a total capacity of 1500 gallons per minute supply mineral oil to the mill stands at about 30/40 lb per square inch through fan-tail jets, and the contaminated oil is returned to a particular compartment of an 18,000-gallon tank. From here the oil passes through Autoklean "Flush-flo" strainers to a second compartment of the tank, but a proportion of the oil



A 15-ton multi-arm turntable transport/charging machine which serves the annealing furnaces and also Nos. 6 and 7 cold mills

is circulated through a fine " Flush-flo " strainer and pre-coat filters, using a Kieselguhr and Fullers earth mixture, before returning to the strained oil compartment. The filtration plant has been installed by the Paterson Engineering Company, Ltd. Fume extraction is by means of induced draught fans exhausting to atmosphere and the mill stands are protected by a built-in $CO_2$ fire-fighting system installed by Walter Kidde and Co., Ltd., while a Mather and Platt " Mulsifyre " installation protects the coolant house.

For finishing material required in coil form there are two trimming and rewinding lines, one for pull through trimming on 36in wide strip, 0·010in to 0·036in thick, and the other equipped with dual pull through and driven trimmers to take strip up to 42in wide and up to 0·064in thick. Both lines have scrap winding equipment. To produce flat sheets the material is processed through a trimming, flattening and shearing line including a Hallden " 51 " pattern flying shear having an aluminium alloy rocking head. There is an automatic air blown stacker for sheets up to 5ft in length and the plant accepts strip ranging from 15in to 38in in width and from 0·008in to 0·048in thick, while the line, which will cut to a maximum length of 12ft, operates at speeds up to 350ft per minute.



**Coils marshalled ready for rolling at the entry side of No. 6 three-stand, four-high, 15in and 28in by 44in tandem mill**

Among the special products of the mill is corrugated sheet, produced in two Streine rotary corrugating machines into which sheets up to 12ft long can be fed broadside. To supplement the corrugating machines in forming special roofing sheets there is a British Clearing 300-ton press brake, manufactured by Vickers-Armstrongs, Ltd., having 16ft clear between housings. Another finishing machine of special interest is the embossing machine, supplied by the Modern Engraving and Machinery Company, U.S.A., which has hydraulically loaded hardened and cambered precision matched embossing rolls suitable for taking sheets from 0·20in to 0·048in thick by 48in wide over a speed range of 78ft to 628ft per minute. At the east end of the north bay is a continuous trimming, degreasing and coiling or cutting-up line, supplied by Imperial Chemical Industries, Ltd., to handle strip up to 3ft. finished width at 60ft per minute. The line consists of a cone decoiler, an automatic spot welding unit for joining consecutive rolls, after which the strip passes through pinch rolls, an edge trimmer with scrap winders and a trichlorethylene degreasing tank. On the outgoing side the strip is wrapped round a traction roll, which can provide drag tension for coil winding or create a slack loop in advance of a Farmer Norton flattening and cutting-up machine, which incorporates a roller leveller and flying shear actuated by a light beam and photo-electric cell.

Circles or other flat blanks are produced by a 50-ton Rhodes blanking press capable of between 50 to 150 strokes per minute. Narrow ribbon stock production is carried out on a pull through slitting machine, having twin drum coilers. Provision has been made also for the continuous anodising of strip up to 24in wide and the equipment includes alkali degreasing, anodising and washing tanks followed by infra-red drying and recoiling.

### Mill Services

A high-pressure hot water system, installed by the Brightside Foundry and Engineering Company, Ltd., meets the demands for space and low temperature process heating and is supplied by three Cochran induced draught "Sinuflo" Economic boilers. Each boiler has a heating capacity of nearly 20,000,000 B.Th.U. per hour and is equipped with Hodgkinson automatic stokers. Two centrifugal pumps, each having a capacity of 970 gallons per minute against a head of 107ft, circulate the hot water at 120 lb per square inch pressure and 320 deg. Fah. A pump capable of delivering 410 gallons per minute against a head of 85ft supplies process and canteen heating requirements and can be supplied by one boiler.

Electricity is supplied by the South East Scotland Area Board at 22kV over two feeders, and there is a 6·6kV standby emergency service. The main transformation down to 6·6kV takes place on two 10MVA transformers and the main switchboard consists of 250MVA oil circuit breakers and the high-tension network feeds six substations. Supplies to the hot mills and strip mills are at 6·6kV, while the factory a.c. services are supplied from thirteen 1250kVA, 6·6kV/415V step-down transformers. A d.c. service is also available from two steel tank pumpless English Electric mercury arc rectifiers, each of 500kW rating.

Water for cooling and other purposes is drawn through a filter from the nearby Forth and Clyde Canal and delivered to the factory by four pumps of 1500 gallons per minute capacity against a head of 120ft. The total circulation is about 4,500,000 gallons per day and practically all is returned to the canal. Three " Broomwade " compressors each supply air at 600 cubic feet per minute at 100 lb. per square inch and there is a fourth unit of 300 cubic feet per minute capacity. The producer gas plant supplied by the Power Gas Corporation, Ltd., consists of six units, employing foundry coke, designed to produce 150,000 cubic feet per hour of gas having a calorific value of 127 B.Th.U. per cubic foot. After washing in Lynn towers the gas passes to six 55 h.p. centrifugal cleaners, which deliver it to the mains at 24in to 27in water gauge and the gas for the annealing and heat-treatment plant is further treated in dry scrubbers. For the storage of oil fuel there are two 500 tons capacity tanks and two of 55 tons capacity, served by two 50 tons per hour transfer pumps, while circulation through the two fuel oil ring mains is by duplicate pumps of 600 and 800 gallons per hour capacity, at 50 lb per square inch.

Extensive and well-equipped workshops are available for effecting maintenance and repairs, and there is a department for internal transport battery charging. There is a separate shop for roll grinding and this is equipped with three machines, manufactured by Craven Brothers (Manchester), Ltd., two of which can accommodate rolls 15ft 6in long by 44in barrel diameter and weighing 24 tons. The third machine can deal with the heavier back-up rolls of the wide hot and cold mills and accommodates rolls having an overall length of 19ft, a barrel diameter of 60in and weighing 50 tons. There is a fourth machine in the shop, which is normally employed on leveller roll grinding and takes work up to 20in diameter and 11ft between centres. The various bays are well served by cranes, the larger being supplied by the Clyde Crane and Engineering Company, Ltd., while the aluminium alloy crane was built by Head Wrightson and Co., Ltd.

## 1·5kW Electric Furnace for Melting Gold

We learn that the first of a batch of specially made electric furnaces was recently completed and tested at the Elecfurn Works of Wild Barfield Electric Furnaces, Ltd., Watford. It is a small equipment designed for the rapid melting of small quantities of gold, and it can also be used for other metals having melting points not above that of gold. This furnace has been developed for the export market and, to keep the equipment simple and of little capital cost, automatic temperature control has been dispensed with and the insulation has been so adjusted that a charge can be melted rapidly without serious danger of over-heating the furnace.

In its general construction the equipment is orthodox, having an angle framework, retaining insulating brick. Four special grooved refractory plates form the chamber and each plate contains heating elements of alloy wire running horizontally in nine grooves. Upper lead-outs are taken down through special corner bricks to a terminal assembly below the furnace. Lower lead-outs are taken direct through the insulation. All have suitable refractory cover tubes. The base of the chamber is fitted with a small removable brick pier to support a crucible. An outer covering of perforated steel plate protects the insulation.

A well-insulated hinged lid is fitted, having provision for the insertion of a thermocouple between the crucible and chamber refractories. Temperature control is effected by means of a hand-operated energy regulator form hand controller. The maximum operating temperature of the furnace is 1200 deg. Cent. It has a nominal rating of 1·5kW.

Aluminium Crane Jibs at Purfleet.—A jetty at Purfleet, owned by Wm. Cory and Son, is equipped with five 7½-ton grabbing cranes supplied by Clyde Crane and Engineering Company, Ltd., which are used principally for unloading coal, sugar, sulphur, &c., from cargo vessels into river barges. Originally it was planned to equip all these cranes with 80ft steel jibs, but it was found necessary to increase the length of two of the jibs to 90ft. To avoid undue increase in the weight of the cranes, which in turn would have called for heavy reinforcement of the existing jetty, aluminium jibs were designed to withstand a 100 per cent overload with a factor of safety of 4in compression and 4·5in tension, these factors being somewhat reduced for the effects of wind loading. Special bulb angle extrusions of " Alminal W.15 " (HE 15 WP) are used for the booms, while the bracing members, also bulb angles, are of " Alminal W.10 " (HE 10 WP). Connections were made with ⅜in diameter cold driven aluminium alloy rivets. Since the high-strength alloy HE 15 WP, used for the main booms, does not possess as high a resistance to industrial and marine atmospheres as does the more normal structural alloy HE 10 WP, it was decided to spray the jibs with a 0·006in thick coating of pure aluminium. They are unpainted. The weight of each 90ft aluminium jib is 2 tons 11¼ cwt compared with the 6 tons 13 cwt of its 80ft steel counterparts. They were fully fabricated in the works of S.M.D. Engineers, Ltd., of Slough, and transported by road to the Albert Docks and thence by barge to Purfleet.

# Cryogenic Engineering Laboratory at Boulder, Colorado

( *By our American Correspondent* )

*An important low-temperature engineering facility, comprising liquid hydrogen and liquid nitrogen plants and a cryogenic laboratory, was recently opened at the National Bureau of Standards site in Boulder, Colorado. Known as the N.B.S.-A.E.C. Cryogenic Engineering Laboratory, the installation makes possible the production on a large scale of liquefied gases which have not previously been available in America in sufficient quantity for laboratory research and industrial development work. The facility was designed in co-operation with the U.S. Atomic Energy Commission and is particularly suited for the development and testing of cryogenic equipment for use at temperatures near absolute zero.*

LIQUEFIED gases at low temperatures are finding increasing applications in industry and therefore have created a need for the development of larger, more convenient and less hazardous equipment for producing and handling these liquids. As a result, many new engineering problems have arisen in the low-temperature field, where much remains to be learned about the behaviour of engineering materials. It is well known that at liquid hydrogen temperatures normally trustworthy structural steels become brittle, rubbers lose their elasticity, and the mechanical properties of plastics are greatly altered. In general, there are such considerable differences between the behaviour of matter at ordinary and at very low temperatures that the low-temperature properties cannot be obtained by extrapolation. The new laboratory of the National Bureau of Standards is at present investigating structural and other engineering properties of matter at low temperatures to provide the data and information which is required in this field and is also developing more satisfactory materials and equipment for use at low temperatures.

The installation at Boulder is situated on a 210-acre site and consists of three principal units : a liquid hydrogen plant, a liquid nitrogen plant, and a group of research and development laboratories. Two concrete main buildings provide a total floor space of 34,000 square feet, and there are also several ancillary buildings and test sites. Both the main buildings are equipped with many safety and anti-explosion devices to minimise the hazards of working with liquid hydrogen in large quantities. The hydrogen liqeufying and purifying equipment, which was designed and constructed by the N.B.S., is in duplicate so that the plant can be operated continuously without shut-down.

## Hydrogen Liquefaction

Liquid hydrogen, the lightest of all known liquids, has a density one-fourteenth that of water and boils at a point 20 deg. Cent. above absolute zero at atmospheric pressure. If, at temperatures above the inversion point of −80 deg. Cent., hydrogen is allowed to undergo a Joule-Thomson expansion through a throttling valve the result is not a cooling effect, as with most other gases, but a heating effect. According to accepted theory, the thermal energy lost by the expanding hydrogen gas in overcoming the relatively slight forces of molecular attraction between the hydrogen molecules is more than balanced by the heat produced as the expanding gas molecules collide in displacing each other. Thus, in order to liquefy hydrogen by expansion, it must first be cooled below −80 deg. Cent. by some other means. It has been established that the further hydrogen is cooled below the inversion temperature before expansion, the greater is the Joule-Thomson cooling effect. For this reason the hydrogen in the N.B.S. liquefier, after first being compressed, is precooled with liquid nitrogen to as low a temperature as possible before the Joule-Thomson expansion takes place. Liquefaction is then accomplished by allowing the compressed, cooled hydrogen to expand through the Joule-Thomson valve from a pressure of about 1800 lb per square inch to atmospheric pressure. To obtain maximum efficiency in cooling during the liquefaction process extensive use is made of counterflow heat exchangers, in which the high-pressure gas is cooled as it passes through coiled tubing surrounded by low-pressure colder gas moving in the opposite direction from a later stage of the liquefaction cycle.

A flow diagram of the " East " half of the duplicate liquid hydrogen plant is reproduced in Fig. 1. Commercial hydrogen is transported to the plant for liquefaction in mobile cylinder banks. The hydrogen is stored in these and in similar stationary cylinder banks at the laboratory at a pressure of 2100 lb to 2400 lb per square inch until needed in the plant. From the storage cylinders the gas flows at a reduced pressure of 25 lb to 50 lb per square inch through a " Deoxo " tank containing a palladium catalyst, which removes small amounts of oxygen by promoting the $O_2+2H_2=2H_2O$ reaction, and then flows to a set of three water-cooled four-stage compressors which are shown in Fig. 2. Two 3000 cubic foot gasholders in the line between the deoxidising equipment and the compressors provide a ballast for the operation of the plant and also serve to maintain a small pressure in the line. Leaving the compressors at room temperature and a pressure of about 2000 lb per square inch, the gas is next purified by means of a system consisting of oil and water separators to remove suspended liquid, a refrigeration drier to remove water and oil vapour, and an adsorption purifier of silica gel cooled to the temperature of liquid nitrogen for the removal of nitrogen and other gases. After the purified hydrogen has given up some of its heat energy in passing through counterflow heat exchangers, further cooling is attained in the liquid nitrogen precooler, where the hydrogen passes through coiled tubing immersed in liquid nitrogen boiling at reduced pressure. Fig. 3 shows the three large reciprocating vacuum pumps which are used to reduce the pressure within the liquid nitrogen precooler. From the precooler the gas passes through a final heat exchanger and then through the Joule-Thomson expansion valve, where part of the hydrogen is

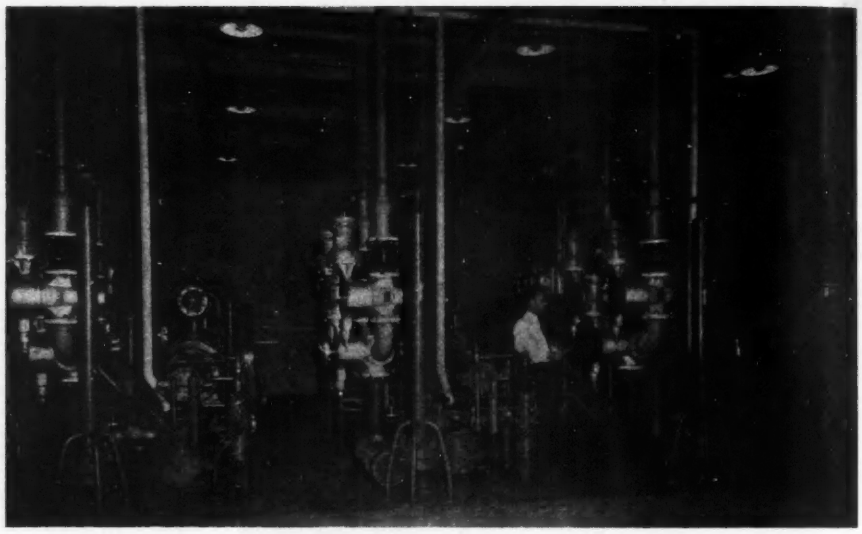


**Fig. 2—Set of water-cooled four-stage hydrogen compressors**

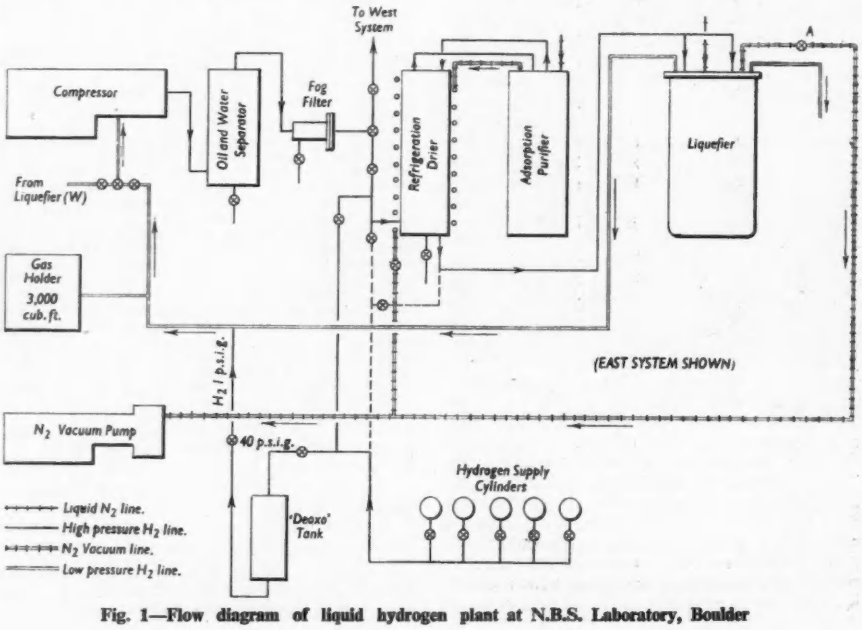



**Fig. 1—Flow diagram of liquid hydrogen plant at N.B.S. Laboratory, Boulder**

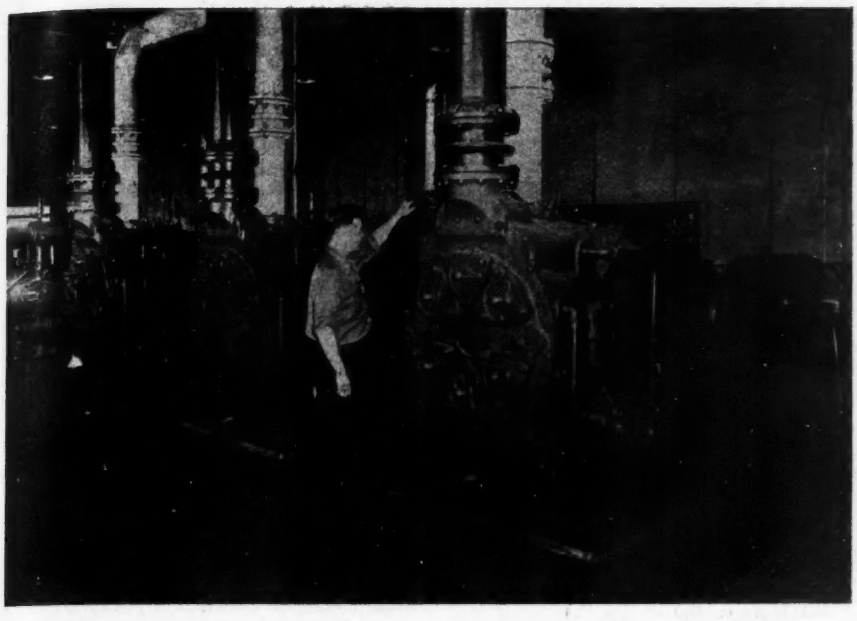


Fig. 3—Set of reciprocating vacuum pumps for reducing the pressure in the nitrogen precooler

liquified by the expansion. Upon leaving the liquefier the liquid hydrogen is transferred into storage containers through vacuum-insulated transfer lines. These " pipelines " have already been used to carry the liquid 50ft or more, and it appears likely that this distance can be greatly extended if desired.

An interesting aspect of the hydrogen liquefier is the fact that all the heat exchangers as well as the liquid nitrogen precooler are contained within a single large insulated 1000-litre metal dewar vacuum " flask " having an internal length of 7ft 6in. and an internal diameter of 2ft 6in. An identical dewar " flask " surrounds the silica-gel adsorption purifier, and both flasks may be seen in the centre of Fig. 4, which shows the liquefying and purifying installation. As the hydrogen liquefying equipment is in duplicate and as each liquefier is provided with two silica-gel purifiers for alternate use, the hydrogen plant contains six of the large dewar flasks altogether. As shown diagrammatically in Fig. 5, the upper two-thirds of the liquefier flask contains three initial heat exchangers and the liquid nitrogen precooler. The heat exchangers are connected in parallel and are equipped with adjusting valves, which permit the distribution of the flow of entering hydrogen between the exchangers in such a way as to obtain maximum efficiency in the cooling process. The lower third of the vessel serves as the liquid hydrogen collection pot. It also contains the final heat exchanger and the Joule-Thomson expansion valve. The portion of the hydrogen which was cooled but not liquefied in passing through the expansion valve is used as a refrigerant in the final heat exchanger and in one of the initial heat exchangers, while the liquid nitrogen vapour from the precooler is the refrigerant in the other two heat exchangers. The refrigeration drier and the silica gel absorption purifier are arranged as a unit. Hydrogen gas enters the drier case at room temperature and passes over heat exchanger tubes, where it is cooled by outflowing gas inside the tubes. The water and oil impurities are condensed out as the gas flows through the drier toward the nitrogen purifier. The gas is finally cooled to liquid nitrogen temperature by passing through a coil submersed in liquid nitrogen in the purifier. At this temperature any nitrogen gas present as an impurity in the hydrogen is readily adsorbed by the silica gel as it flows through the silica gel coil.

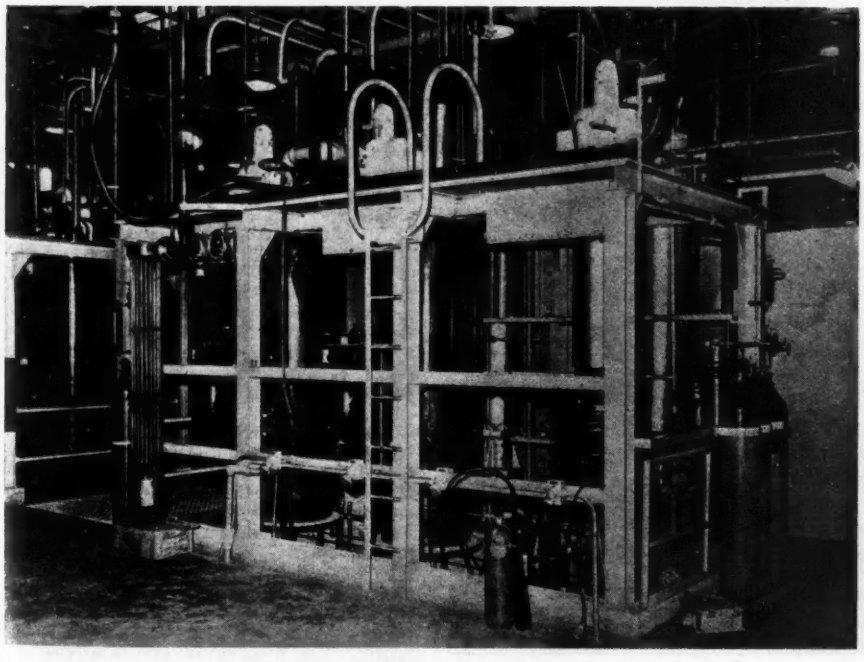


Fig. 4—Hydrogen liquefying and purifying installation

To obtain efficiency and convenience of operation the hydrogen liquefaction system is extensively equipped with automatic instruments, recording devices, and servo-mechanisms, and the master control board of the plant is illustrated in Fig. 6. Level indicators and controllers which were developed by the National Bureau of Standards measure the liquid hydrogen level and automatically maintain the proper level of liquid nitrogen in the adsorption purifier and in the precooler. An automatic control instrument regulates the throttle valves in the vacuum pumping lines to keep the pressure over the pots of boiling liquid nitrogen. Another automatic instrument controls the level of hydrogen within the gasholders, thus ensuring that new hydrogen gas flows into the system at the same rate as liquid hydrogen is taken out. The nitrogen content of the hydrogen is measured by a thermal conductivity apparatus, which was developed in the Chemistry Division of the N.B.S. Finally, whenever a part of the liquefaction plant is not operating properly, a general annunciation system rings a bell and flashes a light which indicates the particular part of the equipment that has to be investigated.

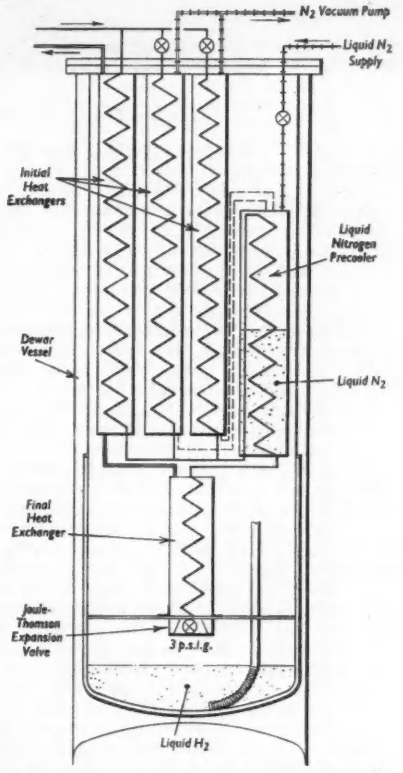



Fig. 5—Diagram of hydrogen liquefying vessel

### Nitrogen Liquefaction

Liquid nitrogen, 99·7 per cent pure, for precooling the high-pressure hydrogen in the liquefier, is produced in the liquid nitrogen plant, which is shown in Fig. 7 and consists of two complete and independent commercial units for purifying and liquefying the gas. Both units are usually operated simultaneously. Two 11,000-litre insulated storage containers, each having a loss rate of about 1·5 per cent a day, make it possible to maintain a large supply of liquid nitrogen at all times. While at atmospheric pressure nitrogen has to be cooled to −196 deg. Cent. for liquefaction, in the plant employed at Boulder liquefaction is attained a few degrees above this temperature because the pressure of the gas is kept somewhat higher. During the course of the process nitrogen is separated from ordinary air drawn in from the roof of the plant and is ultimately cooled to liquefaction by a combination of processes involving refrigeration by contact with colder gases flowing back from

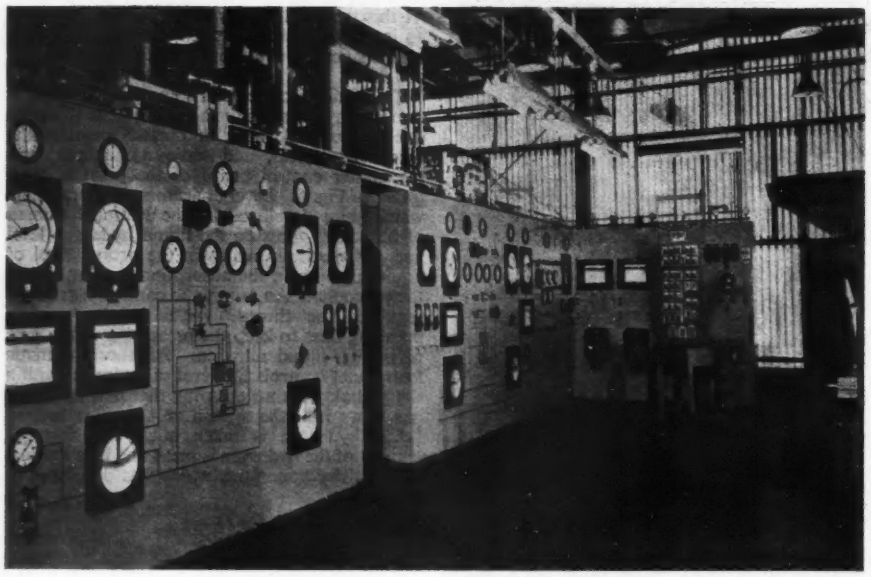


Fig. 6—Master control board of liquid hydrogen plant

later stages of the cycle, expansion through a Joule-Thomson valve and through an air expansion engine, and fractional distillation for the removal of oxygen and further liquefaction.

A simplified flow diagram of the nitrogen liquefaction plant is reproduced in Fig. 8. The air from which the nitrogen is to be separated is first compressed to 3000 lb per square inch in five stages. Between the second and third compression stages it is fed through a tank containing a solution of sodium hydroxide for the removal of carbon dioxide. After three more compression stages have brought the pressure to 3000 lb per square inch the gas flows through a drier containing activated alumina for the removal of moisture. With carbon dioxide and water removed the gas now consists essentially of nitrogen and oxygen at relatively high pressure. It next enters a heat exchanger, which it leaves by two different lines. One line is connected to the cold end of the heat exchanger, having a temperature of about −230 deg. Fah., while the other one is connected at a point where the temperature is about −30 deg. Fah. Through this latter line the high-pressure gas enters an expansion engine. Here its pressure is lowered as it does work against reciprocating pistons. The work thus developed is absorbed by an electric generator, and this loss of energy from the gas results in a lowering of its temperature to about −220 deg. Fah. Further temperature reduction down to the liquefaction point is then obtained by passage through an auxiliary low-pressure heat exchanger.

The line leaving the cold end of the main heat exchanger goes to an expansion valve, where the pressure is reduced to about five atmospheres. The temperature is correspondingly reduced to the liquefaction point by the Joule-Thomson cooling effect, causing a fraction of the air to liquefy. The expansion engine furnishes a considerable amount of refrigeration which indirectly serves to precool the air going to the expansion valve, thus increasing by several times the efficiency of the process. Optimum performance of the system is obtained by regulation of the amount of air taken by the expansion engine, which is controlled by the speed of the engine and the time its intake valve is open. The two streams of partially liquefied nitrogen and oxygen unite and flow to a distillation column, where the liquid nitrogen is separated from the mixture. Refrigeration for the condensation of the nitrogen vapour which accumulates in the top of the distillation column is obtained by piping some of the oxygen-rich liquid in the bottom of the column into a jacket surrounding the top of the column. The liquid nitrogen is continuously tapped off into a reservoir.

Among the many automatic safety devices in the new laboratory is a hydrogen gas indicator, which continuously samples the air at eight points throughout the plant building. Whenever the hydrogen concentration reaches 10 per cent of the lower explosive limit, this device sounds an alarm and automatically closes off all sources of hydrogen. In addition, a ventilating system has been installed, which normally changes the air in the building every two minutes and is automatically speeded up to effect a complete change once a minute when the hydrogen alarm sounds. Other safety precautions include the use of conducting floors to eliminate static sparks, a system which measures the concentration of oxygen in the hydrogen with a sensitivity of 2 parts per million, and means for venting hydrogen to the outdoors in an emergency.

Research and development at the Laboratory are directed principally toward improved means for handling liquid hydrogen and toward increased knowledge of the properties of materials at very low temperatures. The Bureau is now developing apparatus for the low-temperature measurement of the tensile and impact behaviour and fatigue properties of various engineering materials. As a first step toward the accumulation of data on thermal conductivity, apparatus has been designed which provides results in the temperature range from 2 deg. K. to 300 deg. K. Also in the course of design is a large-capacity cryostat, which will be used to provide a controlled environment for many different tests of materials at very low temperatures. The laboratory is also working on the design of more efficient insulated lines for the transfer of liquefied gases. An important part of this project is the development of valves, fittings and couplings that will permit easy assembly, extension and control of flow. Recently the efforts of the N.B.S. to obtain liquid para-hydrogen on a large scale have met with considerable success. Liquid hydrogen, as usually produced, has a high concentration of the molecular form known as the ortho-hydrogen, in which the diatomic molecules have the two nuclear spins oriented in the same direction. But the low-temperature equilibrium form of hydrogen is nearly pure para-hydrogen, in which the nuclear spins in each molecule are opposed. Thus, ordinary liquid hydrogen slowly changes to the "para" form with an accompanying evolution of heat, and this heat causes a serious loss of liquid hydrogen by evaporation. One of the liquefiers at the new laboratory has been equipped with a special catalysing chamber, which results in the production of almost pure liquid para-hydrogen which can be stored with little loss for many days.

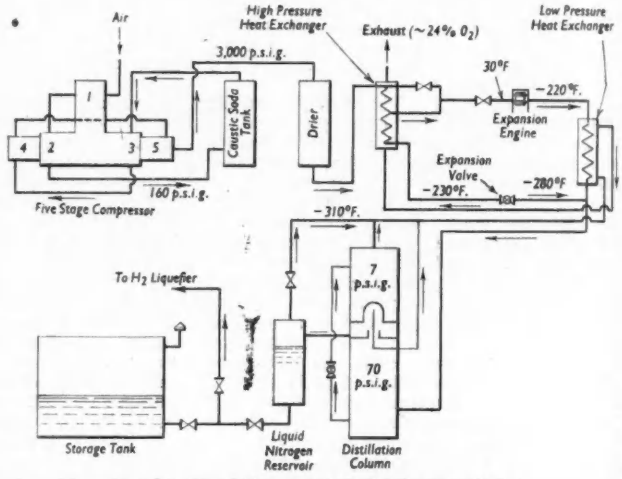



Fig. 8—Flow diagram of liquid nitrogen plant

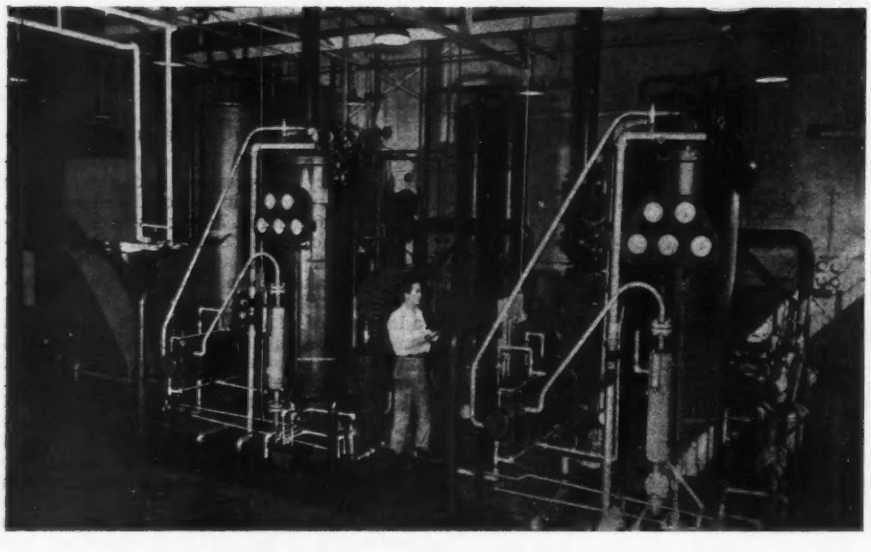


Fig. 7—Liquid nitrogen plant

# Industrial and Labour Notes

### Employment and Unemployment

A report by the Ministry of Labour on the employment situation in Great Britain states that, at the end of April, the working population numbered 23,473,000. The number in civil employment was 22,337,000 (14,907,000 men and 7,430,000 women), which was 63,000 higher than at the end of March.

An analysis of civil employment in April shows that there were 3,998,000 people at work in the basic industries, the main increase during the month being a seasonal one in agriculture. There was an addition of 2000 to mining manpower, the number of workers on colliery books at the end of April being 711,000. In the manufacturing industries during April the number of people employed was 8,970,000, or 16,000 more than at the end of March. The biggest increases in April were 4000 in vehicle building and 6000 in the industries classified under, " engineering, metal goods and precision instruments." The labour forces in these two groups numbered, at the end of April, 1,170,000 and 2,618,000 respectively.

About unemployment, the Ministry's report says that on May 10th there were 289,426 people registered as out of work, compared with 316,585 on April 12th. The May figure, it is stated, included 13,100 who were temporarily stopped, and represented 1·4 per cent of the estimated total number of employees, compared with 1·6 per cent a year ago.

### International Trade Competition

At the end of last week the Treasury and the Board of Trade issued a statement on competition in international trade, setting out the views of the British and German Governments following conversations between the British Chancellor of the Exchequer and the German Federal Minister for Economic Affairs. The statement says that the British and German Governments are convinced that international trade competition should follow natural lines and develop freely. Both Governments regard this as a main condition for the healthy development of international trade and the best means to create smooth relationships between commercial communities and to avoid political-economic tensions.

During the conversations, the Chancellor of the Exchequer emphasised that it was a fundamental part of the British Government's economic policy to restore as soon as possible the freedom of the market over as wide a range of commodities and transactions as possible. Trade in virtually all raw materials used in manufacturing industry had been returned to private enterprise, and commodity markets had reopened for internal and external trade. Reference is made in the statement to the belief sometimes expressed that the price of steel in the United Kingdom is lower than in Germany as a result of some form of subsidy. The statement affirms that the British steel industry receives no subsidy of any kind. It explains that maximum prices at which iron and steel may be sold on the home market are fixed by the Iron and Steel Board, saying that these prices cover the full cost of production and give a fair return on capital. The steel industry, the statement continues, has internal arrangements for spreading the burden of certain costs, particularly of imported materials, more evenly over its output, in a way comparable with the method by which the European Coal and Steel Community countries now spread the higher cost of imported scrap. The United Kingdom, the statement adds, still finds it necessary to control the price of steel scrap and to restrict its export. This price control however, is not in any way connected with Government subsidy arrangements. As regards coal, the National Coal Board in the United Kingdom is under a legal obligation to pay its way without any Government subsidy. The statement explains that the Board's price structure covers the full costs of production and is in no way designed to favour any one class of consumer in the United Kingdom at the expense of another.

The statement ends by saying that the allocation of scarce materials at controlled prices in practice inevitably introduces an element of artificiality into the pattern of production and the distribution of goods as between home and export markets. The Government does not operate any form of open or concealed subsidies for United Kingdom exporters, and seeks the co-operation of other Governments in working towards their abolition generally. In consideration of this statement, the German Federal Minister for Economic Affairs has given notice that it is not his Government's intention to seek renewal of the " Law on Tax Measures for the Furtherance of Exports," which expires at the end of next year.

### F.B.I. Overseas Scholarships Scheme

The Federation of British Industries has published a booklet about its overseas scholarships scheme, which records the progress made with that scheme since it began, in a very modest way, four years ago. It will be recalled that under the scheme young graduate engineers from the less developed countries are enabled to come to this country for practical training.

The F.B.I. says that, since 1950, forty-four scholars have arrived in this country, and that nine of them have already completed their training and have returned home. Eight more are expected shortly. Within the next year or two, however, the Federation hopes that the number of scholarships awarded annually will increase to about 120. As most of them are for a period of two years, this will mean that there will be at least 200 F.B.I. scholars in the country at any one time.

The booklet explains that the object of the scheme is " to bring home to the developing countries a knowledge of what Britain has to offer them." One of the best ways of so doing is to train engineers from those countries which will be concerned with capital development of all kinds, the view being taken that " by exporting engineering training to-day we can expect to export engineering products tomorrow." It is emphasised that, if the scheme is to serve its full purpose, many more firms must participate. Copies of the booklet are available, free of charge, from the Federation of British Industries, 21, Tothill Street, London, S.W.1.

### Industrial Disputes

In the latest issue of the *Ministry of Labour Gazette* a detailed analysis is published of the stoppages of work in the United Kingdom arising from industrial disputes in 1953. The number of these stoppages, reported to the Ministry of Labour as beginning in 1953, was 1746, compared with 1714 in the preceding year. In addition, there were four stoppages which began at the end of 1952 and were still in progress early in 1953, so that altogether last year there were 1750 stoppages of work through disputes. The number of workers affected by them was approximately 1,374,000 and it has been estimated that, in the aggregate, 2,184,000 working days were lost, compared with 1,792,000 days lost in 1952.

By far the largest number of stoppages last year—1307 in all—occurred in the coal mining industry, the aggregate number of working days lost being put at 393,000. The biggest single stoppage of work arising from an industrial dispute last year, however, was the one-day strike in the engineering and shipbuilding industries at the beginning of December, following the rejection of the claim for a 15 per cent wage increase. The number of workers participating in this stoppage has been estimated at about 1,070,000, and this one stoppage accounted for about half of the total number of working days lost during the year.

The Ministry of Labour says that during the period 1914 to 1918 the average yearly number of days lost by stoppages through disputes was about 5,360,000. In the following three years the average was about 49,140,000. From 1922 to 1932 (omitting 1926, the year of the general strike) the yearly average was about 7,560,000 working days. Since 1932, the annual totals have been considerably lower, and in the twenty years, 1934 to 1953, the yearly total of working days lost ranged from 940,000 to 3,710,000, the average being about 1,907,000. During the war years 1940–1945, the average number of days lost by stoppages of work was about 1,980,000.

### Changes in Wage Rates

Changes in wage rates, reported to the Ministry of Labour as coming into effect during April, resulted in increases aggregating approximately £826,000 in the weekly full-time wages of about 2,551,000 workpeople. The principal increases were to those employed in the engineering and allied industries, shipbuilding and ship-repairing, the iron and steel industry, and in railway workshops. Men employed in the electrical contracting industry also received a wage increase.

The wage increases in the engineering and shipbuilding industries resulted from the recent agreement following the rejection of the claim for a 15 per cent increase. In the engineering and allied industries, there were increases of 8s. 6d. a week for skilled men, 7s. 6d. a week for intermediate grades, and 6s. 6d. a week for unskilled men. Women of eighteen and over received a wage increase of 5s. 8d. a week. In shipbuilding and ship-repairing the increases amounted to 8s. 6d., 7s. 6d. or 6s. 6d. a week for men, and 5s. 8d. to 8s. 6d., according to occupation and length of service, for women of twenty-one and over. It has been computed by the Ministry of Labour that these increases add £756,000 to the weekly full-time wages of about 2,161,500 workpeople. In the iron and steel industry, the sliding scale arrangements based on the index of retail prices were amended during April so as to give an increase in most districts of 1s. 1d. for men.

The Ministry of Labour says that in the first four months of this year changes in wage rates led to increases amounting to £1,651,000 in the weekly full-time wages of 5,907,000 workpeople. In the corresponding period of last year, there was a net increase of £1,020,000 a week in the wages of 3,714,000 workpeople. The increases taking effect in April brought the index of rates of wages (June 30th, 1947=100) up to 141 for all workers. Since January, the index had stood at 139.

### Earnings and Hours of Work in the U.S.A.

The United States Bureau of Labour Statistics has recently published a survey of labour developments in the U.S.A. during 1953. It shows that the average earnings of American workers were higher last year than in the preceding post-war years. The gross average weekly earnings of factory workers last year were 71.50 dollars, compared with 68 dollars in 1952.

It is stated that wage increases in many American industries, although moderate in amount compared with those granted in most years from 1946 onwards, together with continued overtime in some industries, helped to maintain weekly and hourly earnings despite a decline in the average length of the working week in the last few months of the year. Among the major American industries in which wage increases were granted were the steel industry. Railway workers, workers in the electrical industries, and those employed in the constructional industries also received wage increases.

The survey says that the length of the average working week in American factories last year was 40·5 hours, compared with an average of 40·7 hours in the two preceding years. Comparing the months after August last with those before, there was a decline of about half an hour in the average length of the working week, although in many industries overtime continued.

# Notes and Memoranda

## Air and Water

COMMODORE OF OIL TANKER FLEET.—We are informed that Captain W. A. Michie, now in command of the 32,000-ton deadweight tanker "British Engineer," has been appointed commodore of the British Tanker Company fleet in succession to Captain J. C. Lea.

LAUNCH OF H.M.S. "IVESTON."—On June 1st a coastal minesweeper H.M.S. "Iveston" was launched from the Noss yard of Philip and Son, Ltd. The ship, which is of composite construction, has a length of 152ft by 28ft 9in beam and propelling machinery supplied by Mirrlees, Bickerton and Day, Ltd.

LAUNCH OF OIL TANKER.—The oil tanker "British Soldier," which is being built by John Brown and Co. (Clydebank), Ltd., for the British Tanker Company, Ltd., has an overall length of 665ft by 85ft 6in beam, a deadweight of 32,000 tons, steam turbine main propelling machinery of 12,500 s.h.p., and a loaded service speed of 15 knots. The ship is to be launched on June 30th, and will be named "British Soldier" by H.R.H. Princess Alexandra.

DEMONSTRATION LAUNCH.—The demonstration launch "Scaramouche," which Grimston Astor, Ltd., has built on the company's "two-way tension" system, recently completed the 600-mile voyage from Bideford to the Thames, at speeds ranging from 16 to 23 knots, according to weather conditions. The launch has a length of 32ft by 9ft 6in beam, a draught of 2ft, a registered tonnage of 4·29 tons, and is mainly constructed of No. 12 gauge aluminium alloy sheet to standard specification N.S.5. Propulsion is by twin Ford "V.8" petrol motors directly driving three-bladed manganese bronze propellers to give a crusing speed of 23 knots at 2650 r.p.m. and a maximum speed of 25 knots with the motors running at 3000 r.p.m.

## Miscellanea

KWINANA REFINERY.—By the end of this year it is expected that the dredging of a channel 500ft wide by 34ft deep will be completed to allow medium-size tankers to enter Cockburn Sound and deliver cargoes of crude oil to the refinery. Dredging of the channel is to continue to attain a depth of 38ft to enable 30,000-ton tankers to reach the refinery.

INSTITUTION OF STRUCTURAL ENGINEERS.—At the annual general meeting of the Institution of Structural Engineers which was held on May 27th, honorary officers and members of the Council were elected for the session 1954–55. The president for the session is Dr. S. B. Hamilton, and the vice-presidents are Mr. S. Vaughan, Mr. J. Guthrie Brown, Professor A. G. Pugsley, Mr. G. S. McDonald, Mr. L. E. Kent, and Mr. W. H. Woodcock.

MR. GEORGE PUGSLEY.—We have learned with regret of the death of Mr. George Pugsley, chairman and managing director of Joseph Pugsley and Sons, Ltd., Bristol, which occurred on May 28th. Mr. Pugsley, who was seventy-five, had been actively associated with the business—which was founded by his father—for nearly sixty years. He had been a director since the present company was formed in 1916, becoming managing director in 1921 and chairman in 1928.

MINISTRY OF WORKS BUILDING PLANT EXHIBITION, 1954.—Some sixty exhibitors will be showing their latest machines, equipment and powered tools at this year's "Building Plant Exhibition," organised by the Ministry of Works, which is to be held at Reading. It will be opened on Thursday, June 24th, by Mr. J. R. Bevins, M.P., Parliamentary Secretary to the Ministry of Works. The exhibits will occupy more than 300,000 square feet and there is a demonstration area of about 20,000 square feet, where machines will be seen in operation.

E.C.E. POWER COMMITTEE'S MEETING.—The United Nations' Economic Commission for Europe's Committee on Electric Power opened its eleventh session in Geneva recently. The Committee is studying economic, technical and legal problems connected with the development of European electricity resources. One of the principal aims of the committee is to promote transfers of electricity between the different European countries which would make for the rational integration of Europe's electric power resources and for optimum efficiency in the operation of the different national grids.

FILM ON PRESTRESSED CONCRETE.—A film about the various aspects of pretensioned, prestressed concrete as applied to building construction has been made by Concrete, Ltd., 16, Northumberland Avenue, London, W.C.2. The film runs for twenty-five minutes and includes sequences which show the general principles of prestressed and reinforced concrete, the performance and testing of a prestressed concrete and a reinforced concrete slab, the manufacture of hollow floor slabs, and the erection of precast units. The precast prestressed units shown in the film include 60ft hollow beams being erected to form a garage roof.

HYDRAULIC POWER KIT.—An industrial power kit now being made by Epco, Ltd., Star Works, Leeds, 7, is designed to provide a handy, portable, hydraulic tool for engineers and maintenance fitters. This kit consists of a manually operated hydraulic pump which forces oil through a 6ft length of high-pressure flexible hose to a hydraulic ram unit to which a series of pushing and pulling attachments can be fitted. It is made in two sizes, one of 20 tons and the other of 8 tons capacity, the heavy unit having a self-retracting ram with a 5in effective stroke, and the smaller model a ram with a 6in power stroke. Each kit, complete with a selection of attachments, is supplied in a sheet metal chest ready for easy transport between working points.

BARRIER CREAMS.—A film entitled "Safe Hands" has been made by Scientific Pharmacals, Ltd., to show the protection afforded by its "Kerodex" barrier creams against industrial dermatitis and the application and use of creams against typical hazards encountered by workers in various industries. Copies of this film are available for private showing by industrial organisations, and inquiries should be sent to the Press Relations Officer, Scientific Pharmacals, Ltd., 1, Eden Street, London, N.W.1.

PUBLICATIONS OF THE NATIONAL CIVIL ENGINEERING LABORATORY, LISBON.—We have received from the Laboratorio Nacional de Engenharia Civil of Lisbon a number of technical publications, in the Portuguese language, concerning the laboratory's recent work. They include two reports on statistical analysis (Nos. 45 and 47); a report on hydraulic model studies of harbour works (No. 39); two reports on wood preservation, one giving details of a non-destructive testing technique to measure wood decay (No. 48), and the other devoted to damage and treatment of woodwork in Madeira Island due to a species of termite (No. 44); a report on modular building construction (No. 40); and a report on soil mechanics (No. 46).

PRESENTATION TO MR. A. R. STOCK.—The Institution of Mechanical Engineers has included, in *The Chartered Mechanical Engineer*, some account of a presentation of a canteen of silver made recently to Mr. Alfred R. Stock to commemorate the completion of fifty years on the Institution staff. Mr. Stock joined the staff of the Institution in April, 1904, as a library assistant, and in 1920 he was appointed librarian. At that time the number of books sent out on loan during a year was 639; in the year 1952 the corresponding figure exceeded 13,000. Mr. Stock retired from the office of librarian last year, but has since been assisting in another section of the Institution's work. At the presentation, Sir William Stanier paid tribute to Mr. Stock's work during his long years of service to the Institution. It is a tribute which is warmly supported, not only by the members of the Institution, but also by representatives of the technical press and others who have benefited by Mr. Stock's able and courteous help in the library at 1, Birdcage Walk, Westminster.

TELEVISION TOWER AT CRYSTAL PALACE.—Some details of the tower which British Insulated Callender's Construction Company, Ltd., is to design and erect for the B.B.C., to its detailed specifications at the new London television station at Crystal Palace, have been sent to us by that company. The new tower is to be a lattice-steel structure, 640ft in height, with a base width of 120ft. For the first 440ft it will taper and from this point until it reaches the height of 600ft will be of 9ft 6in sided square section. The top 40ft of the tower, which is also to be of square section, will have parallel sides of 2ft 6in face width. The structure will be designed to resist wind pressures varying from 27 lb per square foot at the base to 55 lb per square foot at the top. Allowance has been made for icing. Between the 440ft and 660ft levels eight stacks of four dipole aerials will be mounted and at 440ft provision will be made for the installation of dish type receiving aerials for picking up outside broadcast transmissions. The foundations of the tower will provide for the possibility of future underground extensions of the transmitter buildings beneath the structure. The tower itself will be provided with an electrically operated hoist to carry two passengers or a goods load of 5 cwt to a height of 440ft. The whole structure will be of bolted construction and will weigh approximately 370 tons. All structural members and connections will be hot dipped galvanised at the works of Painter Brothers Ltd., Hereford, who will fabricate the steelwork.

TEST ON A 55FT SPAN PRESTRESSED CONCRETE BEAM.—At the request of the Lee Conservancy Catchment Board the Cement and Concrete Association recently carried out a test to destruction on a 55ft span Lee-McCall prestressed beam. The beam was designed for a culvert 55ft wide and approximately 2140ft long, which was to be covered by similar beams placed side by side and joined by transverse stressing in groups of twenty. Each beam was cast in two sections, approximately two-thirds and one-third respectively of the total length of 57ft, which were mortar joined together before stressing with three 1¼in diameter Macalloy bars and grouted at 50 lb per square inch with a neat cement grout. The section of the beam was of I-shape with a depth of 2ft 6in and width of 1ft 11¼in, there being five full width web stiffeners along the length. The I-section increased to the full rectangular section at each end. The test was carried out with the beam simply supported on a 55ft span and live load was applied to the top flange of the beam, at two points 3ft each side of the span centre, by means of a hydraulic jack and distributing beam. The jack force was measured by a "statimeter" placed between the piston head and the distributing beam. With this arrangement the design bending moment of 3,855,000 lb-in, was produced in the centre 6ft length of the beam with a jack force of 11·7 tons. During the test measurements were taken of the central deflection of the beam, and the strain in the concrete was measured on three gauge lengths placed on one side of the beam only, 1ft 6in from the span centre. The procedure adopted in the test was to apply the load to the beam in small increments until the centre span stresses were slightly in excess of their design values, and then to release the load. The load was again applied up to a maximum of 1·5 times the design condition and released. Finally, the load was again applied and increased until failure occurred. The applied load which caused failure of the beam was 27·9 tons, which introduced a bending moment of 9,200,000 lb-in at the centre of the span. With the dead load moment of 1,470,000 lb-in the ultimate moment had a value of 10,670,000 lb-in.

ALUMINIUM SHEET AND PLATE DATA.—We have received from High Duty Alloys, Ltd., a booklet with the title "Hiduminium Sheet and Plate Technical Data," which gives particulars of rolling mill products, fabricated products and continues with notes on fabrication, including references to bending, press work and welding. Sizes of flat and corrugated sheet are listed and tables set forth the composition and mechanical properties of various alloys while other tabular statements contain useful information concerning tolerances, gauge conversion and weights of standard size sheets. Another booklet published by the company gives the foreign equivalents of Hiduminium casting and wrought alloys.

NEW WICKMAN OFFICES.—The new office block at the Banner Lane Factory of Wickman, Ltd., built to replace the offices destroyed by fire in March, 1952, has now been completed. The new building provides 35,000 square feet accommodation on two floors, and is located in front of the existing factory building. Although the new offices provide more accommodation than existed prior to the fire, the expansion in the company's activities since that time has necessitated the retention of the works and offices at Fletchamstead Highway, Coventry, which were used as temporary administrative headquarters and as permanent offices for the company's factored machine tool division. From these offices the sales and servicing for the British and imported machine tools handled by the company on an agency basis will in future be conducted. A demonstration hall is also being built, where machine tools can be demonstrated under power.

## Personal and Business

MR. REX BATE, M.I.E.E., has been appointed sales director of Enfield Cables, Ltd.

MR. G. R. MARSH has been appointed managing director of Wickman, Ltd., Coventry.

REAR-ADMIRAL (E.) H. J. B. GRYLLS has been appointed engineer manager, Devonport Dockyard.

MR. T. B. DEGENHARDT has been appointed education officer of the Institute of Cost and Works Accountants.

MR. R. ELLIS, A.M.I.Mech.E., has been appointed manager of British United Traction, Ltd., Leyland, Lancs.

MR. LEWIS BURN, M.I.Mech.E., has joined Armstrong Whitworth (Metal Industries), Ltd., as engineer consultant.

FOLLAND AIRCRAFT, Ltd., Hamble, Southampton, states that Mr. S. Rymell has been appointed deputy chief inspector.

MR. KENNETH CROXTON has been appointed a director of Geo. Robson and Co. (Conveyors), Ltd., Hodgson Street, Sheffield, 3.

MR. T. E. PARKINSON has been appointed sales manager of Mortimer Engineering Company, 210, Acton Lane, London, N.W.10.

MR. M. E. O'K. TROWBRIDGE has been appointed general sales manager of Sharples Centrifuges, Ltd., Woodchester, Glos.

MR. N. V. BALDWIN has been appointed managing director of Brookhirst Igranic S.A. (Pty.), Ltd., 19, Link Road, Langlaagte, Johannesburg.

MINNESOTA MINING AND MANUFACTURING COMPANY, Ltd., Adderley Park, Birmingham, has opened a sales office at 90, Mitchell Street, Glasgow, C.1 (telephone, City 6704).

COMMANDER C. M. JACOB, R.N. (Ret.), has been appointed deputy technical manager of the Marconi International Marine Communication Company, Ltd., Chelmsford.

HOPKINSONS, Ltd., Huddersfield, announces the appointment of Mr. J. M. Griffiths as manager of the centrifugal purifier department following the retirement of Mr. A. R. Sutcliffe.

SHEEPBRIDGE ENGINEERING, Ltd., announces a change in the name of Sheepbridge Steel Castings, Ltd., one of its subsidiaries. In future that company will be known as Sheepbridge Alloy Castings, Ltd. Its address is Sutton-in-Ashfield, Notts.

DALTON ENGINEERING CO. (BLYTH), Ltd., is now known as Dalton Engineering Activities (Newcastle), Ltd. Its office address has been changed to 34, Great North Road, Newcastle upon Tyne, 2. The company's works remain at Cramlington.

RUDKIN AND RILEY, Ltd., Aylestone, Leicester, has been appointed sole distributor at home and overseas of the wire drawing die profiloscopes made by the Longworth Scientific Instrument Company, Ltd., and designed by the British Iron and Steel Research Association.

CUPODEL, Ltd., Birmingham, has now become associated with Keith Blackman, Ltd. The registered office of Cupodel, Ltd., is now at Mill Mead Road, Tottenham, London, N.17, and its Birmingham office at 1294, Bristol Road South, Northfield, Birmingham, 31.

MR. H. T. WORDSWORTH has retired from the board of Sanderson Brothers and Newbould, Ltd., Sheffield, owing to ill health. He has been in the company's service for fifty-six years and was appointed a director in 1931. Mr. John Lonsdale, works manager, has been appointed a director.

MR. GORDON ROACH and MR. MONTAGUE HOLBEIN, of D. and C. and William Press, Ltd., 27, Ashley Place, London, S.W.1, have concluded the purchase of the Canadian firm of Ross-Meagher, Ltd., civil engineers and building contractors. It is announced that Ross-Meagher will now exploit the gas line laying and other techniques in which the purchasers specialise.

# British Patent Specifications

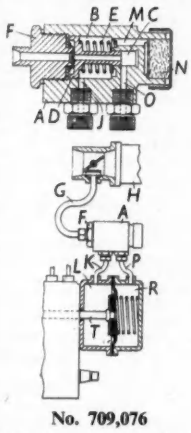
*When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.*

*Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.*

## INTERNAL COMBUSTION ENGINES

**709,076.** October 26, 1951.—AN ANTI-REVERSAL DEVICE, C.A.V., Ltd., Warple Way, Acton, London, W.3. (*Inventor: Wilfred Edward Walter Nicolls.*)

The object of the invention is to provide a simple device for interrupting the fuel supply in the event of accidental reverse rotation of the engine. As shown in the upper drawing, there is a body *A* containing two chambers *B* and *C* of different diameters, the smaller chamber *C* being open at one end to the adjacent end of the larger chamber *B*. In these chambers is a stepped piston *D* having an axial bore, the piston being loaded by a spring *E*. One end of the large chamber has a bored connection *F* whereby this end can be connected by a pipe *G* to a venturi throat at the entrance end of the air intake manifold *H*. The chamber is also provided with a lateral port *J* which is connected by a pipe *K* to the compartment *L* of the governor, which is normally in communication with the atmosphere. The port *J* is controlled by the part of the piston *D*. Also a passage *M* is provided in the valve body part *A* leading from the chamber *B* to the atmosphere. If desired, an air filter *N* may be fitted on this passage. The chamber *C* has a lateral port *O* connected by a pipe *P* to the compartment *R* of the governor, which is normally in communication with the venturi throat in the intake manifold, this communication being effected by way of the axial bore in the piston and the pipe *G*. The port *O* is controlled by the piston part of smaller diameter. The arrangement is such that during normal running of the engine, the piston occupies the position shown in the upper view, and communication between the manifold and the governor is effected through the bore in the piston and the port *O*, communication between the governor and opening to the atmosphere being through the other port *J* and the passage *M*. In this condition, the governor operates in its normal manner. But in the event of an accidental reversal in the direction of motion of the engine, resulting in a reversal of the pressure condition in the manifold, the positive pressure then acting on the larger end of the piston will move it against the action of the spring. This causes the governor compartment *L* previously open to the atmosphere to be put into communication with the manifold, the other compartment *R* being put into communication with the atmosphere. In this condition, the governor diaphragm will move the rack bar *T* to a position in which it interrupts the supply of fuel to stop the engine.—*May* 12, 1954.

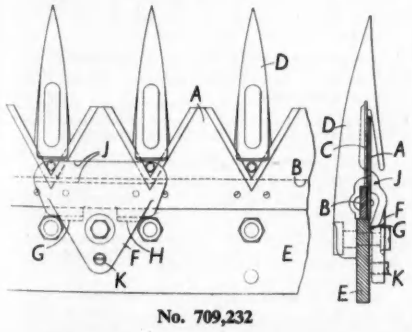



No. 709,076

## AGRICULTURAL ENGINEERING

**709,232.** November 21, 1951.—MOTOR SCYTHES AND MOWING HARVESTING MACHINES, James John Cullimore Allen, "Wootten," Iffley, in City and County of Oxford.

The invention relates to an improved mounting of motor scythe cutter blades to ensure their continued and uniform contact with the fixed blades. In the drawing it will be seen that a number of cutter blades *A* are riveted to a cutter bar *B*, which is driven by the motor, being reciprocable with respect to a number of fixed blades *C*, secured to fingers *D* on a bar *E*. A number of pressure pads, only one, *F*, of which is shown, are secured to the finger bar and bear on the cutter blades. Each pad is secured by a bolt passing into the finger bar and is formed with a pair of aligned ridges *G* and *H* bearing on the top face of the finger bar and a bearing surface *J* bearing on the top face of the cutter blades. Its bearing length is such that it overlaps the width of one cutter blade. An adjusting screw *K* passes through the apex of the pad to bear on the finger bar. In use, the retaining bolt is loosened and the adjusting screw turned until the bearing surface of the pad bears on the cutter blades to maintain them in contact with the fixed blades and the bolt is tightened. In this way it is possible to provide a very simple means of adjusting the pressure on the cutter blades by pads which have a large bearing surface.—*May* 19, 1954.

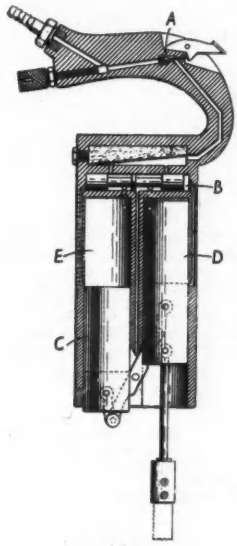



No. 709,232

## TOOLS AND WORKSHOP APPLIANCES

**709,149.** February 14, 1952.—PORTABLE PNEUMATIC TOOLS, Austin Cartwright Mercer, 222, Rooley Lane, Bradford.

As will be seen from the drawing, the tool has a piston-grip handle with a passage leading from a hose connection to a trigger controlled valve *A* to a lubricating chamber. From this chamber there are two ports leading into a valve chamber *B* in which a double-headed piston valve operates. The ends of the valve chamber communicate with the cylinders by passages in the body of the tool and also down the walls of the cylinders to the other end of the piston. The pistons *C* and *D* are single acting and are bifurcated at the forward ends and are connected by pivoted links and a rocker arm so that they move in opposite directions. The two pistons and their associated parts are balanced by making piston *C* of steel and piston *D* of aluminium. The tool can have different types of nose for varying kinds of work and, as shown in the drawing, the tool to be used can be directly connected to one of the pistons through a guide block which slides in the nose of the tool. By means of the air cushioning of the pistons and the removal of side thrust from the piston and the tool, it operates smoothly at high speed.—*May* 19, 1954.

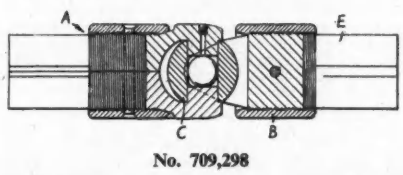



No. 709,149

## POWER TRANSMISSION

**709,298.** October 31, 1951.—TORQUE-TRANSMITTING UNIVERSAL JOINTS, Reginald Bishop, 145, The Vale, Golders Green, London, N.W.11.

As shown in the drawing, the joint is constructed from seven parts, four of which are identical fork parts indicated generally at *A* and two of which are sleeve or nut parts *B*, the remaining part being a connecting element *C* in the form of a sphere having two diametrical bores at right angles to each other with their axes in the same plane. The outer or free ends of the composite shanks may be formed with flats *E* or splines for connection to shafts. The manner of assembling the universal joint will be clear from the drawing. The construction of the universal joint and the production is relatively simple, particularly so far as the fork parts are concerned. A modified design is also shown in the specification.—*May* 19, 1954.

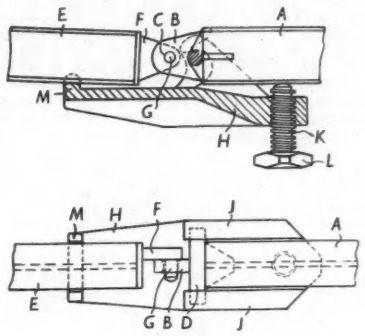



No. 709,298

## MINING ENGINEERING

**709,241.** March 3, 1952.—CAP SHOES FOR MINE ROOF SUPPORTS, De Directie van de Staatsmijnen in Limburg, handelend voor en namens den Staat der Nederlanden, 2, van der Maesenstraat, Heerlen, The Netherlands.

As the drawing shows, on to the girder *A*, supported by a pit prop, a nose *B* is welded at the end nearer the coal face, the nose being provided with a hole *C* and a pin *D*, situated behind it. The girder *E* has a nose *F* and a side pin *G* attached to it. The other end of the girder may likewise be provided with a nose and a side pin. For mounting the girder *E* to the end of the girder *A*, a cap shoe *H* is suspended on the pin *D* of the girder *A*. For this purpose the cap shoe is provided with hook portions *J*, which are engaged over the ends of the pin. Subsequently the pin *G* of the girder *E* is engaged in the hole *C* and the thrust screw *K* is turned to press against the bottom flange of the girder, the wings *L* being provided for applying the power to move the screw. The end *M* of the cap shoe is thus forced upwards to press the girder *E* against the roof to be supported.—*May* 19, 1954.




No. 709,241

# Technical Reports

*Fire Hazards of Internal Linings.* National Building Studies Special Report No. 22, D.S.I.R. H.M. Stationery Office. Price 1s. 3d., postage 4½d.—Since the war there has been a great increase in the use of building boards as internal linings for walls and ceilings. These boards have many advantages, but when used in certain ways some of them can contribute to the rapid growth of fire, particularly during the early stages. Experiments carried out at the Fire Research Station to assess the fire hazard of different types of board and the efficiency of various flame-retardant treatments are given in this report. The results are summarised in a form that will help in interpreting the results of the "Surface Spread of Flame Test" of B.S. 476.

*The Rheology of Non-Aqueous Suspensions.* Road Research Technical Paper No. 28, D.S.I.R. H.M. Stationery Office. Price 2s.—Knowledge of the flow properties of mixtures of powdered solids and liquids other than water is of importance in many industries, and investigations made at the Road Research Laboratory over a number of years on suspensions of this type are described in this report. The powders used for the work included limestone, granites, slate, silica, slag and Portland cement. Some of the tests were made with very fine powders collected from air-separating systems or were specially prepared in a ball mill. Two types of liquid were used for the suspension of the powders. One was a refined coal tar obtained from the high-temperature carbonisation of coal and consisting of hydrocarbons of a predominantly aromatic character, the other a bitumen containing hydrocarbons of a predominantly aliphatic nature, which was obtained as a residue in the distillation of crude petroleum. Both liquids had a similar viscosity at a temperature of 15 deg. Cent. and behaved substantially as simple Newtonian liquids at temperatures above that figure.

The main problem was to find the effect on the flow properties of the mixture of the amount and physical characteristics of the powder used, particularly when it was present in large quantities. The work was therefore concerned first with the study of the flow properties of two-phase systems and secondly with the physical characteristics of finely divided materials. The first part of the paper describes a

systematic study of the flow properties of the powder/liquid suspensions over a wide range of concentration. The results showed the importance of the voids fraction in the dry powders. The second part describes work on the void structure of the packed powders and the third part relates the results to the rheological behaviour of systems of high solid concentration.

*Road Research Technical Paper No.* 30 : "*A Study of Single-sized Gravel Aggregates for Roadmaking.*" H.M. Stationery Office. Price 1s.—This report gives a summary of the results of tests on nearly 300 samples of single-sized gravel, together with information on modes of occurrence, distribution, classification and methods of production, and the main requirements for single-sized gravels for use in different forms of road construction. The investigation was carried out as part of a survey of gravel production to obtain data needed to help in drawing up the new British Standard for Single-sized Gravel Aggregates (B.S. 1984 : 1953).

In many parts of Great Britain gravel is the cheapest local aggregate, but in the past, a high proportion has been sold either "as dug" or after processing only by washing and removing the sand. Increasing knowledge of the properties required in roadmaking aggregates has led to a demand for closely graded "single-sized" aggregates. These can be remixed to give more accurate control over gradings for normal concrete or coated macadam, or can be used singly or in combination with a controlled proportion of fines in gap-graded concrete, granular road bases, stone-filled asphalt or surface dressings.

The main objects in producing this report have been to gather together under one cover for the information of engineers and producers all the available information on single-sized gravel aggregates and to show their wide field of application in roadmaking. The investigations were assisted by the Ballast, Sand and Allied Trades Association.

## British Standards Institution

***All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.***

### GEAR HOBBING MACHINES FOR TURBINES AND SIMILAR DRIVES

No. 1498 : 1954. Price 4s. The drafting of this specification was undertaken in the first instance at the request of the Admiralty for the purpose of establishing standards of accuracy for gear hobbing machines intended for the production of high-grade gears for turbines and similar drives. Close collaboration was maintained throughout with the Government departments concerned, with engineering institutions and research associations and with manufacturers and users of these machines.

This first revision of the standard introduces a number of amendments in detail which have been found desirable as the result of experience in its use. The two grades of accuracy originally specified are maintained : Grade A for machines capable of producing gears for relatively heavy loads with high pitch line velocity, and Grade B for machines suitable for producing high-quality gears for normal loads and pitch line velocities.

The text has been revised and the sections rearranged in a more logical sequence, and a chart showing maximum permissible transverse pitch errors, based on the formulæ given in the text, has been added.

### COAL CUTTER PICKS AND PICK BOXES

No. 2477 : 1954. Price 2s. The manufacturers of coal cutters and coal cutter picks, together with the National Coal Board, agreed upon the necessity for a British Standard covering coal cutter picks and pick boxes to provide interchangeability between cutter picks made by different firms, and to reduce, as far as is consistent with efficiency, the number of types and sizes in order to simplify ordering and manufacture.

The standard, which has been prepared gives dimensions necessary to ensure interchangeability between the picks and pick boxes, and specifies requirements for the minimum cutting gauge of the picks. It provides also for the effective fastening of the pick shank in the pick box.

In order to distinguish between the different types of pick used, the one having a hard metal (tungsten carbide) tip, brazed either on the surface of the body or in a slot, is designated in the standard as "pick, brazed-on tip type." All other types, including the plain steel pick and the steel pick with any of a variety of metal weld deposited at the cutting point, are designated "picks, other than brazed-on tip type."

The technical committee responsible for preparing the standard considered including requirements for materials, but in view of the developments at present being undertaken, it was decided that a specification for materials should be omitted from the present edition.

### GLOSSARY OF TERMS RELATING TO IRON AND STEEL

No. 2094 : 1954. Six parts. Part I. 6s., other parts 2s. 6d. each. The six parts of this glossary of terms relating to iron and steel are as follows :—Part I, general metallurgical, heat-treatment and testing terms ; Part 2, steel making ; Part 3, hot-rolled steel products (excluding sheet, strip and tubes) ; Part 4, steel sheet and strip ; Part 5, bright steel bar and steel wire ; and Part 6, forgings and drop forgings. It will be seen that Part I, covering general metallurgical heat-treatment and testing terms, is complementary to the other parts of the glossary which deal with particular sections of the industry.

The glossary has been prepared to establish as far as possible uniformity in the interpretation of the numerous terms in current use, and the scope has been limited to those terms in general use in the different producing sections of the iron and steel industry. Terms dealing with the various applications of iron and steel products, e.g. in welding and electrical engineering, are covered in other British Standard glossaries.

## Launches and Trial Trips

HUNTSLAND, cargo ship ; built by the Burntisland Shipbuilding Company, Ltd., for the Power Steamship Company, Ltd. ; length between perpendiculars 450ft, breadth 64ft, depth moulded to shelter deck 40ft 5in, deadweight 11,650 tons, draught loaded 27ft ; five cargo holds, six 5-ton, four 10-ton, one 40-ton and one 5-ton derricks, electric deck machinery ; Hawthorn-Doxford oil engine, six cylinders 670mm diameter by 2320mm combined stroke, 6600 b.h.p.—Launch, May 20th.

FOUNTAINS ABBEY, cargo ship ; built by Hall, Russell and Co., Ltd., for Associated Humber Lines ; length between perpendiculars 240ft, breadth moulded 38ft 6in, depth moulded to shelter deck 21ft 6in, deadweight 1100 tons on 13ft 5in draught ; three cargo holds, one 15-ton and six 7-ton derricks, electrical deck machinery ; Kincaid Polar diesel engine, 2100 b.h.p. at 220 r.p.m.—Launch, May 31st.

ATHELMERE, oil tanker ; built by R. and W. Hawthorn, Leslie and Co., Ltd., for the Athel Line, Ltd. ; length overall 459ft, breadth moulded 61ft, depth moulded 31ft, deadweight 10,000 tons ; twenty main cargo oil tanks, twelve summer tanks, one cargo pump room, two cargo oil pumps, one molasses pump ; Hawthorn-Doxford oil engine, four cylinders 670mm diameter by 2320mm combined stroke, 4450 b.h.p. at 112 r.p.m. ; two cylindrical boilers, two 100kW diesel-driven generators, one 50kW steam-driven generator.—Launch, June 1st.

HADRIANIA, oil tanker ; built by Smith's Dock Company, Ltd., for Shell Tankers, Ltd. ; length between perpendiculars 530ft, breadth moulded 69ft 3in, depth moulded 39ft, deadweight 18,000 tons on 29ft 6in draught, service speed 14·5 knots ; thirty-three cargo oil tanks, one cargo pump room, four 400 tons per hour turbo-driven cargo pumps ; one set of Hawthorn, Leslie two-casing, double reduction geared turbines, steam supplied at 500 lb per square inch and 800 deg. Fah. by two Foster-Wheeler marine "D" pattern boilers, two 550kW turbo-alternators, one 200kW diesel alternator.—Launch, June 1st.

PONTIA, oil tanker ; built by Harland and Wolff, Ltd., for Pelagos A/S ; length between perpendiculars 465ft, breadth moulded 61ft 6in, depth moulded 35ft 6in, deadweight 13,200 tons on 27ft 10in draught ; twenty-four cargo oil tanks, two cargo pump rooms ; one 75kW diesel-driven generator, two 50kW steam-driven generators ; Harland -B. and W. single-acting, four stroke diesel engine, six cylinders, 740mm diameter by 1500mm stroke, 115 r.p.m., two multitubular boilers.—Launch, June 2nd.

HAMINA, cargo ship ; built by John Lewis and Sons, Ltd., for A/S William Hansen Rederi 11 ; length between perpendiculars 275ft, breadth moulded 44ft, depth moulded 21ft 9in, deadweight 3100 tons ; two cargo holds, eight 5-ton derricks ; Lewis-Doxford oil engine, 1450 b.h.p., three 150kW and one 25kW generators.—Launch, June 3rd.

VESSEL No. 237, oil tanker ; built by John Crown and Sons, Ltd., for Rolf Wigard Skipsrederi, Norway ; length between perpendiculars 516ft, breadth moulded 73ft, depth moulded 41ft 1in, deadweight 18,250 tons on 30ft 6in draught ; twenty-six cargo oil tanks, two cargo pump rooms ; Sulzer diesel engine, nine cylinders, 720mm diameter by 1250mm stroke, 6300 b.h.p. at 125 r.p.m., service speed 14 knots ; after part of ship launched.—Launch, June 4th.

M.O.T. ELEVATOR No. 5, grain elevating pontoon ; built by the Goole Shipbuilding and Repairing Company, Ltd., for Simon Handling Engineers, Ltd. ; length 87ft, breadth 37ft 6in, depth moulded 15ft.—Launch, June 5th.

TINTAGEL CASTLE, cargo liner ; built by Harland and Wolff, Ltd., for the Union Castle Mail Steamship Company, Ltd. ; length overall 493ft, length between perpendiculars 465ft, breadth moulded 65ft 6in, depth moulded to shelter deck 41ft 6in, gross tonnage 7450 ; twelve passengers ; two steel decks, eight water-tight bulkheads, five main cargo holds ; one 80-ton, two 30-ton, eight 10-ton and eight 5-ton derricks, electric deck machinery ; three 250kW diesel-driven generators ; Harland and Wolff double-acting, two cycle diesel engine, eight cylinders, 620mm diameter by 1400mm stroke.—Trial, June 5th.

## Catalogues

EPCO, Ltd., Star Works, Leeds, 7.—Brochure describing Flexi-Force hydraulic power kits.

SAUNDERS VALVE COMPANY, Ltd., Cwmbran, Newport, Mon.—Leaflet describing the Saunders "M" cock.

AERO HEAT TREATMENTS, Ltd., Sarehole Road, Hall Green, Birmingham, 28.—Leaflet entitled "For Perfectionists Only."

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., Loughborough.—Publication No. 51103, on Brush power transformers.

AIR CONTROL INSTALLATIONS, Ltd., Ruislip, Middlesex.—Publication No. F.A. 534, describing the "Windovent" window fan.

B.S.A. TOOLS, Ltd., Mackadown Lane, Kitts Green, Birmingham, 33.—Leaflet describing alloy steel castings for jigs, tools and dies.

THE POWER GAS CORPORATION, Ltd., Stockton-on-Tees.—Leaflet describing high-purity low-cost package carbon dioxide plant.

BROWN AND TAWSE TUBES, Ltd., St. Leonard's Street, Bromley-by-Bow, London, E.3.—Catalogue No. 108, Valves, Cocks and Fittings.

THE ENGLISH ELECTRIC COMPANY, Ltd., Queens House, Kingsway, London, W.C.2. — Brochure describing English Electric traction.

CROSBY VALVE AND ENGINEERING COMPANY, Ltd., Crosby Works, Ealing Road, Wembley.—Catalogue K 1600 on automatic controls.

HOLSET ENGINEERING COMPANY, Ltd., Turnbridge, Huddersfield.—Catalogue No. 101, describing flexible rubber block couplings and gears.

HARLAND DRIVES, Ltd., 20, Park Street, London, W.1.—Booklet describing Harland drives for paper and board making machines.

NETTLE ACCESSORIES, Ltd., Harper Road, Wythenshawe, Manchester.—Leaflet describing Nettle shockproof electrical accessories.

STANDARD TELEPHONES AND CABLES, Ltd., Oakleigh Road, New Southgate, London, N.11.—Leaflet D/Rc 25, Individual Relay Units.

STANDARD TELEPHONES AND CABLES, Ltd., North Woolwich, London, E.16.—Bulletin C/MT. 17, describing the 74701 acoustic mill feed controller.

REFRIGERATOR COMPONENTS, Ltd., 1 and 2, Greycoat Place, Westminster, London, S.W.1.—Leaflet describing the Eezi-Charge service dryer.

SALFORD ELECTRICAL INSTRUMENTS, Ltd., Peel Works, Silk Street, Salford, 3. Lancs.—Leaflet describing the S.E.I. electromagnetic transducer system.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., 21, Bloomsbury Street, London, W.C.1.—Booklet describing trolley-bus and tramway overhead equipment.

THE HOFFMANN MANUFACTURING COMPANY, Ltd., Chelmsford, Essex.—Booklet entitled "A Sketch of the Manufacture of Hoffmann Ball and Roller Bearings."

THE EXCELSIOR MOTOR COMPANY, Ltd., Kings Road, Tyseley, Birmingham, 11.—Leaflet describing additional models in the Pyramid lightweight motor truck range.

MONOMETER MANUFACTURING COMPANY, Ltd., Savoy House, 115–116, Strand, London, W.C.2.—Leaflet describing the "Monometer" lip-axis tilting furnace.

MARSHALL RICHARDS MACHINE COMPANY, Ltd., Crook, Co. Durham.—Leaflet on wire and tube drawing machinery and superfine wire drawing machine, type "10–F."

SOUTH BEND LATHE WORKS, 425, East Madison Street, South Bend 22, Indiana, U.S.A.—Catalogue 5406, South Bend precision lathes, drill presses, shapers and pedestal grinders.

W. EDWARDS AND CO. (LONDON), Ltd., Manor Royal, Crawley, Sussex.—Technical Leaflets E.149/2, "Vacuum Forming Machine Model 'V.F.2'"; C.109/3, "Vacuum Switch 'VSK.1'"; B 118/1, "Vapour 'Speedivac' Pumps"; E.148/1, "Glass Working Machine, Model 'G.3'"; D 141/1, "Ionization Gauge Heads and Control Units"; D.141/2, "Palladium Leak Detector, Model '3A.'"

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### BRITISH ROAD FEDERATION

*Mon., June 21st.*—Royal Empire Society, 18, Northumberland Avenue, London, W.C.2, "The Development of a Modern Highway System," D. C. Greer, 6 p.m.

### INSTITUTE OF METALS

*Wed., June 30th.*—GENERAL MEETING : 4, Grosvenor Gardens, London, S.W.1, "The Brittle Fracture of Metals : Some New Developments," E. Orowan, 5 p.m.

### INSTITUTE OF NAVIGATION

*Fri., June 18th.*—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Methods of Training in Navigation," Discussion introduced by W. L. S. Harrison, 5 p.m.

### INSTITUTION OF ELECTRICAL ENGINEERS

*To-day, June 11th.*—MEASUREMENTS SECTION : Summer Visit to Rugby and Bourneville.

*Fri., June 18th.*—EDUCATION DISCUSSION CIRCLE : Engineering Laboratory, The Polytechnic, Battersea, Exhibition of Apparatus, 6 p.m.

### INSTITUTION OF MECHANICAL ENGINEERS

*Mon., June 14th.*—N.E. BRANCH : Stephenson Building, King's College, University of Durham, "The Place of Sir Charles Parsons in the History of Mechanical Engineering," Aubrey Burstall, 6 p.m.

*Tues., Wed. and Fri., June 15th, 16th and 18th.*—Stephenson Building, King's College, University of Durham, Sir Charles Parsons Centenary Exhibition, 7 p.m. to 8.30 p.m.

### JUNIOR INSTITUTION OF ENGINEERS

*Mon., June 21st.*—EXTRAORDINARY GENERAL MEETING : Townsend House, Greycoat Place, London, S.W.1, 6 p.m.

### WOMEN'S ENGINEERING SOCIETY

*Wed., June 16th.*—LONDON BRANCH : 35, Grosvenor Place, London, S.W.1, Annual General Meeting, 7 p.m.